User Manual

A2

Audio Test & Measurement System

Version 3.1E
A2 firmware V2.0 or higher

CE DECLARATION OF CONFORMITY

We, the manufacturer

NTI AG
Im alten Riet 102
FL - 9494 Schaan
Principality of Liechtenstein, Europe

hereby declare that the product

Product Name	Audio Test & Service System
Model Number	A2
Year of Construction	1995

conforms to the following standards or other normative documents

EC-Rules	89/392, 91/368, 93/44, 93/68, 73/23, 89/336, 92/31
Harmonized Standards	IEC 65, IEC 68-2-31, IEC 348 EN50081-1, EN50082-1, EN50140, EN 61010-1

This declaration becomes void in case of any changes on the product without written authorization by NTI.

Date	Schaan, 28. 02. 1995
Signature	
Position of Signatory	Product Manager Test Instruments

CE

Samples of this instrument have been tested and found to conform with the statutory protective requirements. Instruments of this type thus meet all requirements to be given the CE mark.

INTERNATIONAL WARRANTY

Limited Warranty

NTI guarantees the A2/A2-D Audio Test & Service System and its components against defects in material or workmanship for a period of one year from the date of original purchase, and agrees to repair or to replace any defective unit at no cost for either parts or labour during this period.

Restrictions

This warranty does not cover damages that have resulted of accidents, misuse, lack of care, the attachment or installation of any components that were not provided with the product, loss of parts or connecting the instrument to any other power supply, input signal voltage or connector type than specified. In particular, no responsibility is granted for special, incidental, or consequential damages.

This warranty becomes void if servicing or repairs of the product are performed by any other party than an authorized service center.

No other warranty, written or oral, is authorized by NTI. Except as otherwise stated in this warranty, NTI makes no representation or warranty of any kind, expressed or implied in law or in fact, including, without limitation, merchasing or fitting for any particular purpose and assumes no liability, either in tort, strict liability, contract or warranty for products.

Note

In case of malfunction, take - or ship prepaid - your NTI A2/A2-D Audio Test & Service System, packed in the original packing, to your nearest authorized service center. Be sure to include a copy of your sales invoice as proof of purchase date. Transit damages are not covered by this warranty.

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1. INTRODUCTION

Safety Information

Please read this safety information thoroughly before starting to operate the A2.

- The NTI A2/A2-D Audio Test & Measurement System was designed to be connected to a specified mains power source with safety grounding through an approved three-wire mains power cable.

NEVER operate the instrument with missing or compromised safety ground connection.

- To avoid fire hazard, the mains power fuse of the A2/A2-D must be replaced in case of failure by a fuse with the correct rating (see chapter 2. ***Installation***).
- For safety reasons never apply voltages higher than $200V_{RMS}$ or 300Vp to the measurement inputs of the A2. Voltages higher than that may permanently destroy the internal electronics.
- There are no parts inside the instrument that may be repaired or replaced by the user. Therefore, never open the unit for any reason.

Do not try to service the instrument unless properly qualified.

Overview

The NTI A2 is a comprehensive, high performance two-channel audio test set. It includes a flexible generator, based on a Digital Signal Processor (DSP) and a high performance analyzer providing a wide variety of measurement functions, as there are

- Level absolute (two-channel) in µV, mV, V, dBV and dBu or dBm
- Level relative in *1, % and dBr
- Level selective in µV, mV, V, dBV and dBu / dBm
- Total harmonic distortion & noise (THD+N) in % and dB
- IMD (Intermodulation distortion) in % and dB
- Wow & Flutter in %
- Noise (absolute), weighted and unweighted, in µVq, mVq, Vq and d Bq
- Noise (relative), weighted and unweighted, in *1, % and dBr
- Crosstalk (frequency selective) in *1, % and dBr
- Frequency (two channels simultaneously)
- Phase (interchannel) in the range of ±180°.

In the METER display mode, all measurement results are displayed in numerical form as large digits and in analog form through a bar-graph. Additional parameters like the I/O-frequencies and impedances, the input levels and the generator settings are permantly shown.

The standard sweep capabilities of the A2/A2-D allow to perform

- Frequency sweeps
- Amplitude Sweeps
- Time Sweeps
- Table sweeps with freely definable pairs of frequency and level (with Option AO1)

Sweeps can be controlled by the built-in generator or by an external source (e.g. test tapes, test CDs or other NTI A-series instruments) at a remote location. Several traces can be recorded and displayed in the GRAPH mode, while up to four complete graphs may be stored in the internal non-volatile memory of the A2/A2-D. This allows for instance to record swept measurements in a studio and to print out the results in the office later.

Another powerful diagnostic aid of the A2 is the SCOPE function. In this mode, the waveform of both input channels is shown on the LC-display just like on a dual trace oscilloscope. If set to the THD+N function, the A2/A2-D shows both the original signal and the distortion residual. In other measurement functions, the main input signal is shown as a single trace.

All measurements of level - except noise - are true RMS rectified. Noise is measured as quasi-peak value according to the CCIR 468-3 standard. Both a 400Hz high-pass and a 22Hz-22kHz band-pass filter are available as a standard.

The two inputs of the A2/A2-D are DC-isolated up to ±300Vp, and equipped with selectable input impedances to optimally match the output impedance of the device under test (DUT). As an option, both inputs may also be Phantom-powered.
The normalized input signals are available at the BNC connectors at the rear panel of the instrument. A small, built-in loudspeaker allows acoustical monitoring of the measured signal.

The versatile generator of the A2/A2-D, based on a Digital Signal Processor, is capable of generating a large number of different test signals over the full level & frequency range.

- Low distortion pure sine signal
- Low distortion warbled sine
- Dual-tone IMD signal, covering all standards
- Symmetric square wave (50:50 duty cycle)
- Asymmetric square wave (40:60 duty cycle for phase reverse check)
- White noise
- Pink noise

The output impedance (<15Ω up to 600Ω) can be adjusted in a wide range as well in order to match the input impedance of the device to be tested.

As an option, a RS-232 serial or IEEE-488 parallel interface may be installed into the instrument to remote control all A2/A2-D features from a PC.
Regardless of the type of interface, AS04, a comprehensive Windows™ based software package is included, supporting all operation modes, offering the possibility to store all results, and allowing to write program sequences in the easy-to-learn Audio Measurement Sequence Language (AMSL) for fully automatic measurements.

How to use this Manual

This User Manual has been written to serve as a complete reference document for using the A2/A2-D as a solution for your measurement requirements. Maintenance procedures, such as installation of the instrument, are placed at the beginning while not so frequently required tasks such as re-calibration are filed at the end of the manual.

The best way to familiarize with the instrument is to place the A2/A2-D in front of you and to read through the chapters ***2. Installation*** and ***3. Getting Started***. This way, it won't take long to feel at ease with the instrument and its many features.

Do not operate the instrument without reading through the chapter *2. Installation*. Important information about mains voltage selection and fuse rating is given therein.

2. INSTALLATION

Unpacking

Your new A2/A2-D comes along together with some accessories. Please check whether all of the following items are enclosed.

- A2/A2D Audio Test & Service System
- Mains power cable
- Spare fuse for 110VAC
- A pair of rack-mount wings
- This User Manual.

It is strongly recommended to save the original cardboard box for the case that it ever becomes necessary to ship the A2/A2-D. Never ship the instrument in a box not properly protecting the unit against mechanical shock, since the NTI warranty does not cover damages caused by improper packing.

Options and Accessories

Besides the wide range of already built-in features of the A2/A2-D, there are some optional items available for the A2/A2-D as listed in chapter ***8. Instrument Setup***. Please ask your local NTI agency for further details.

Environmental Conditions

The A2/A2D test system will operate in accordance with its specifications as long as the environmental conditions are kept within the following ranges.

Temperature	5°-45° Celsius
Humidity	10-90% non condensing

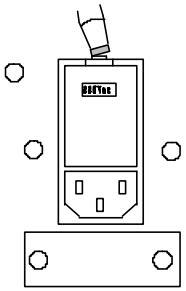
Mains Power Supply

After having unpacked the unit, it is first necessary to connect the system to the AC mains power of your country. For this purpose, the enclosed mains power cable has an unconnected end with three colored leads, corresponding to

Brown	=	Live
Blue	=	Ground
Green/Yellow	=	Earth

Attach a mains plug to this end of the cable, fitting to the receptacles of your area. Next, make sure that the mains power voltage matches the power selection that is shown on the mains power connector/fuse holder assembly on the rear panel of the A2/A2-D. If this selection is incompatible with the available power source, go through the following paragraph to adjust the mains power requirements.

The A2/A2-D2 can operate from 100VAC, 120VAC, 230VAC or 240VAC. To configure the input line voltage of the A2/A2-D, remove the mains cable and open the flap of the connector/fuse holder assembly at the rear panle of the A2/A2-D by pressing a small screwdriver into the slot on the top or ruin your fingernails.



Take out the drum and insert it in the new, required position. The label pointing towards the operator indicates the selected line voltage.

At the same time, insert a new fuse with the proper current rating must. For 100VAC and120VAC, a 2A fuse has to be used, while for 230VAC and 240VAC a 1A fuse is required.

After having set the required line voltage and installation of the proper fuse, close the flap and insert the power cable.

The A2/A2-D is designed to be connected to protective ground (earth) through the ground wire in the power cable. This connection is essential for safe operation.

NEVER operate the instrument if the safety ground connection is not available or has been compromised.

Printer Connection

The CENTRONICS printer connector is located at the rear panel of the A2/A2-D. It is a 25-pin female D-type connector - the same as installed in a standard PC.
To select the required printer driver, please refer to the chapter ***7. Printouts***. The appendix describes in detail the pin assignment and the timing of the CENTRONICS port.

Interface to PC

Connection The RS232C serial or IEEE-488 parallel interface is available as an option together with the software package AS04 to control the A2/A2-D as a remote unit. As long as this interface is not installed, the hole for the connector is covered with a blanking plate.
Both interface types can be upgraded at a later time by inserting a sub circuit. Please refer to the chapter ***8. Instrument Setup*** for more detailed information.

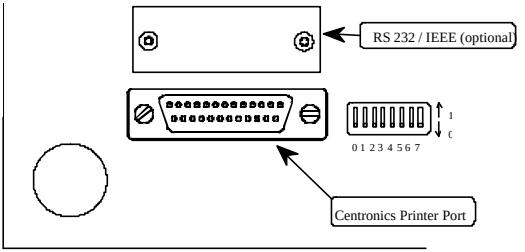


Fig. 1 Rear Panel Interface Connectors

3. GETTING STARTED

Read this chapter carefully to become familiar with the operation of the A2/A2-D.
Further details are filed in the following chapters.

The NTI A2/A2-D system is very easy to operate, despite its large number of functions and the variety of options & settings. Since the user interface is arranged in logical blocks and every key correlated to a certain function, operation of the unit is virtually self-explaining.

Nevertheless, regardless of the keys that are pressed, the internal logic of the system takes care that every measurement is done according to the specified standards.

Measurement Functions

The measurement-related keys are arranged on the top row of the right hand side of the A2/A2-D keyboard. Any measurement function may be selected at any time by pressing the respective key.

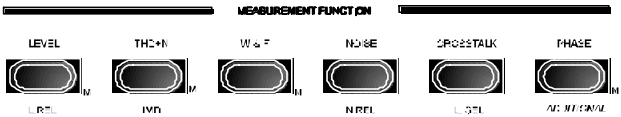
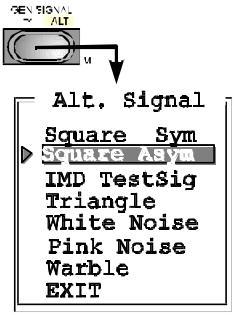


Fig. 2 Measurement Function Keys

Some of the keys provide two selections, thus allowing to select another related measurement (e.g. <THD+N> and <IMD>). To activate the second function, simply press the key once more and the measurement mode will toggle. The actually selected function is permanently displayed.

Menu Operation

To allow the user to activate a special option or setup, several menus may be opened by double-clicking any of the keys marked with a capital "M" in the bottom right (see ***p. 19***).



As soon as the menu is open, a list of selections appears, with the currently active selection being displayed in inverted characters.
In this example, by double-clicking the <GEN SIGNAL> key, the *Alt. Signal* menu appears.

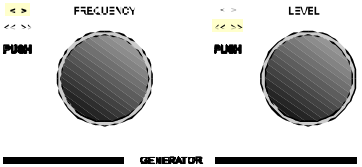
To change the actual setting, the small triangle arrow on the left hand side may be moved to any entry of the menu by turning the <SCALE> wheel. To confirm the chosen entry, press the <SCALE> wheel once.

If a new selection has been confirmed, the menu will be closed. Alternatively, leave the menu through the *EXIT* entry or by prressing any key.

NOTE ***While a menu is open, any other keypress than to the <SCALE> wheel will close the menu and execute the new command.***

Generator Settings

The generator output frequency & level can be selected by the two softwheels labeled with <FREQUENCY> and <LEVEL>.



Neither frequency nor level can be changed continuously - as with a poti-controlled analog generator - but in discrete steps only.
By pushing the softwheel once, the stepwidth toggles between *fine* (< >) and *coarse* (« ») mode. The actual selection is indicated by a lit LED behind the corresponding sign.

By turning the <FREQUENCY> or <LEVEL> wheels *slowly* or *quickly*, the width of the step up/down to the next value may be small or large as listed in ***Table 1***.

	<FREQUENCY>	<LEVEL>
Coarse mode, *quick* turn	10Hz - 20Hz - 100Hz - 1kHz - 10kHz - 40kHz - 100kHz	± 20dB (*logarithmic* units) or factor 10 (*linear* units)
Coarse mode, *slow* turn	± 12.5%	± 2dB / ± 25.9%
Fine mode, *quick* turn	3rd-octave steps	± 2dB / ~ factor 2
Fine mode, *slow* turn	± 0.5%	± 0.04dB / ± 0.5%

Table 1 Softwheel Steps

Furthermore, the two generator outputs A and B can be muted by pressing the respective <MUTE> keys. Otherwise, i.e. if they are muted, both outputs are permanently active.

The Display Modes

With the three *DISPLAY MODE* keys, the user may select one of the available modes, regardless of the actual measurement function.

- The METER mode displays the single results together with all additional measurement parameters.
- Sweeps may be displayed in the GRAPH mode.
- The SCOPE mode shows the waveform of the input signal in the time domain.

All these modes can be selected at any time without affecting the actual measurement (e.g. also during a running sweep).

To increase the lifetime of the backlight of the LC-display, it is automatically switched Off if no key or wheel on the instrument is used for several minutes. However, any keypress immediately re-lights the illumination.

Sweep Operation

Sweeps are best performed in the display mode GRAPH, that continuously displays the setup parameters and the recorded curve(s) on the LCD.

The specific sweep setup may be selected through the keys of the SWEEP block.

Fig. 3 SWEEP Block

Basically, there are 5 sweep modes available, that can be called through the menu behind the key <SWEEP MODE>.

- *Frequency* sweeps measure the actually selected function vs. a changing frequency
- *Tape* sweeps allow to record a defined frequency pattern on a tape
- *Amplitude* sweeps measure the actually selected function vs. a changing amplitude
- *Time* sweeps measure the actually selected function vs. time
- *Table* sweeps allow to measure the actually selected function vs. a previously defined frequency / amplitude table (requires RS232 or IEEE-488 option)

Furthermore, the <SWEEP MODE> key allows to toggle between internally and externally generated sweeps.

To define the *start / stop value* of the X-axis (e.g. 20Hz / 20kHz for a frequency sweep), set the generator to the desired value and press the <START> / <STOP> key respectively.

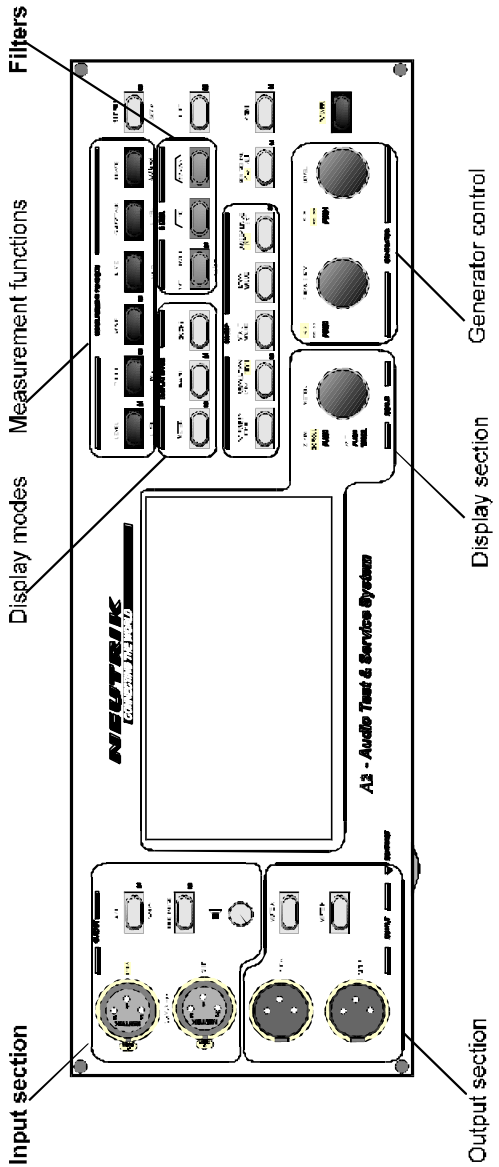
Choose the *resolution* of your sweep, i.e. the number of samples to be recorded, through the <RESOLUTION> key. Both modes (LOW / HIGH) allow to set the required number of measurements by entering the sweep resolution menu.

The recording of a new sweep is started by pressing the <DO SWEEP / STOP> key, while a running sweep may be stopped through the same action.

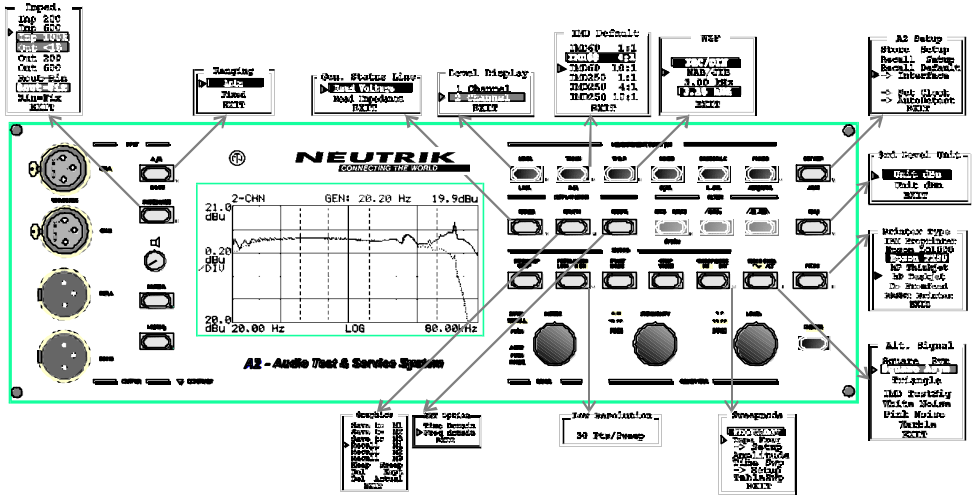
Several sweeps may be permanently stored by entering the menu behind the <GRAPH> button, and selecting one of the four avilable memory locations (M1-M3). By this way, up to four complete graphs with a max. of 6 curves per graph may be stored in the non-volatile memory of thze A2/A2-D for a later printout or upload to a PC.

NOTE This is only a very brief description of the sweep capabilities of the A2. Please refer also to the chapter 6. Sweeps to see all the possibilities.

The A2/A2-D User Interface



A2/A2-D Menu Overview

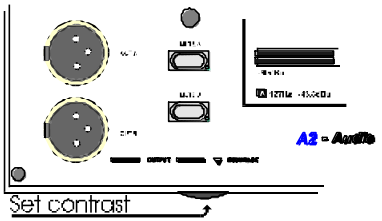


4. A2/A2-D OPERATION

> ***NOTE*** ***Before switching On your A2/A2-D, make sure that the selected mains power voltage matches the one of your area. If not, please refer to chapter 2. Installation to set it correctly.***

Each time the A2/A2-D is switched On, it performs a short self-test, during which the A2 logo will be displayed together with the software version, the current time setting of the internal clock and the serial number of the unit.

After this test, the A2/A2-D will present itself in the last active setup, i.e. show the same settings and selections as when it was switched off. Nevertheless, it is also possible to define and recall a user setup (see chapter ***Store & Recall Setups***).



If necessary, one may tilt the instrument slightly either by turning the carrying handle below the underside or use the reversible footings in order to optimze the view on the LCD.

Furthermore, you may adjust the contrast of the LC-display to your demands by turning the potentiometer wheel on the left hand side.

The A2/A2-D is equipped with a screen saver function to extend the lifetime of the LCD backlight. The backlight darkens after ~10 minutes without any operator activity. To turn it On again, simply press any key or softwheel.

Input Section

The A2/A2-D is a two-channel measurement system, providing two fully independent measurement channels, named *MAIN* and *ALTERNATE*. Both channels are equipped with an input impedance circuitry, input attenuators/amplifiers and a filter bank. This allows e.g. to measure weighted or unweighted levels of both channels simultaneously.

Additionally, the *main* channel analyzer is equipped with a special filter section for Harmonic Distortion, Intermodulation and Noise measurements, and also provides the demodulator and filtering for W&F measurements.

The <A / B> key allows to select which of the input connectors shall be the main channel of the instrument. In other terms, the input signal of the illuminated (i.e. active) channel is always fed to the main channel, while the other input signal is fed to the alternate channel.

Input Block Diagram

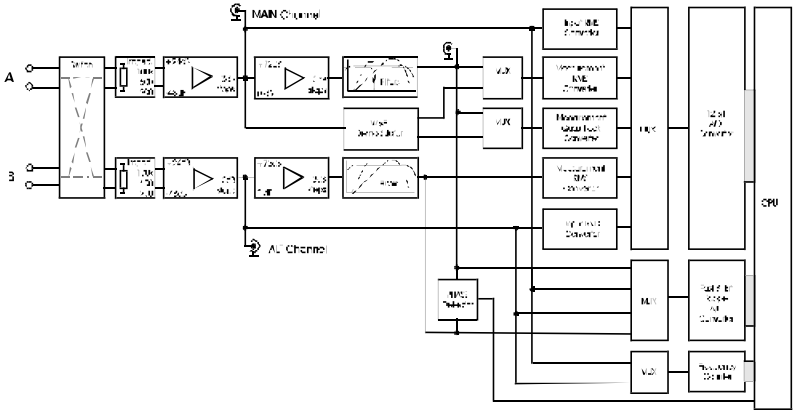
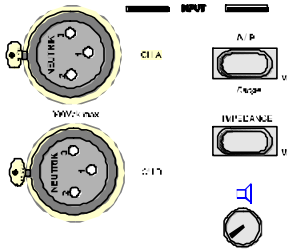


Fig. 4 Block Diagram Analyzer

Input Wiring & Impedances

Both input channels are fully balanced and terminated with defined impedances right behind the input connectors Threesettings are available.



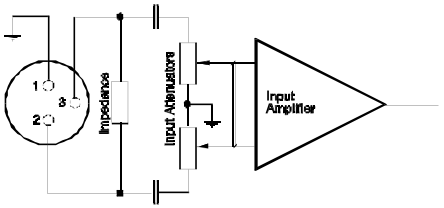
- The highest possible impedance terminates the inputs with 100kΩ, corresponding a voltage matching by means of a minimum load to the output of the device under test.
- The second value, 600Ω, is intended for all instruments with this output impedance.
- The low input impedance can be set to 150Ω or 200Ω.

Choose one of these three settings by pressing the <IMPEDANCE> button. Each keypress will toggle to the next impedance. The actually selected impedance is displayed on the left hand side on top of the METER panel.

***NOTE** As soon as a level of more than 20V is applied to one of the inputs, the LOW and MEDIUM impedance selections will be disabled automatically to protect the inputs from being destroyed. An alert message will inform you accordingly in this case.*

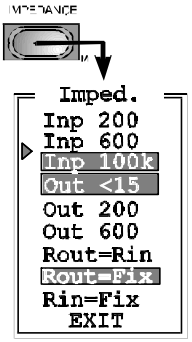
If the LOW impedance is activated, NEVER apply an input voltage > 60V, since higher voltages can permanently destroy the electronics!

The figure below shows the simplified input wiring and the connector pin assignment of one channel. The circuit is a true instrument-grade differential input. Both input pins (2 and 3) are loaded with ~100kOhm to ground. Additionally, the input impedances are applied between the two pins. The inputs are fed to the microprocessor-controlled input attenuator/amplifier, that adjusts the level of the input signal in order to achieve a high dynamic range at very a very low distortion.



Input / Output Impedance Selection

In addition to the input impedance selection, a menu is available to choose all available configurations of the input and output impedances. To enter this menu, double-click on the <IMPEDANCE> key.



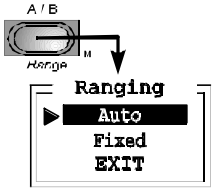
The *Imped.* menu allows either to couple the input to the output impedance, or to let the operator fix one impedance while having the other one switchable. To select your preference, move the arrow with the <SCALE> wheel and confirm your selection by pushing the <SCALE> wheel once. Always leave the menu through the *EXIT* entry.

Optionally, the input connectors of the A2/A2-D can be equipped with a +15VDC or +48VDC Phantom power to directly connect a capacitor type microphone. Please notice, that the Phantom power option replaces the LOW input impedance. Please refer to chapter ***Phantom Power (AO8)*** for more details.
Depending on the configuration, the displayed input impedance on the second line on the METER display, reads *Inp 200*, *Inp 150* or *Phantom* .

NOTE If the Phantom power option is installed, the 200W (150W) input impedance is not available.

Auto / Fixed Range

The menu behind the <A / B> key allows you to choose between the *Auto* and *Fixed* range setting. In the *Auto* range mode, i.e. the normal mode, the operator never has to worry about the settings of the input amplifiers.
However, for some applications like testing short bursts, it might be helpful to lock the amplifiers in a certain state.



The *Fixed* range selection locks the input attenuators/amplifiers in their actual state as soon as it is chosen by a push on the <SCALE> softwheel.

If the input signal level is under or over the actual *Fixed* range, then the messages *TOO LOW* or *TOO HIGH* will appear on the LCD instead of a measurement result.

To lock the input attenuators/amplifiers to a fixed range, proceed as follows.

- Apply the input signal, to which you want to adjust the ranging.
- Call the Ranging menu by double-clicking to the <A / B> button.
- Select the entry *Fixed* by positioning the arrow through the <SCALE> wheel. Push the wheel once to activate the setting (the menu closes automatically). The input stages are now fixed, and all measurements will be performed in this mode.
- To switch back to automatic ranging (normal mode), enter the menu again and select *Auto*.

NOTE The input attenuators/amplifiers of the analyzer remain fixed in their range as long as the Fixed range mode is active.

Connection of a Balanced Output to the A2/A2-D

The device under test (DUT) is connected between pin 2 (IN +) and pin 3 (IN -) of the XLR input connector. The shield may be connected to pin 1, but **do not** ground the shield on both ends of the connection, in order to avoid ground loops.

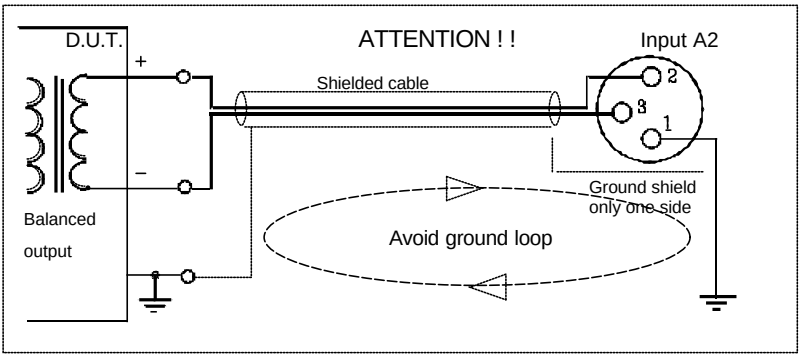


Fig. 5 Balanced Connection to the A2/A2-D

Connection of an Unbalanced Output to the A2/A2-D

The device under test (DUT) is connected between pin 2 (Signal +) and pin 3 (GND) of the XLR input connector.

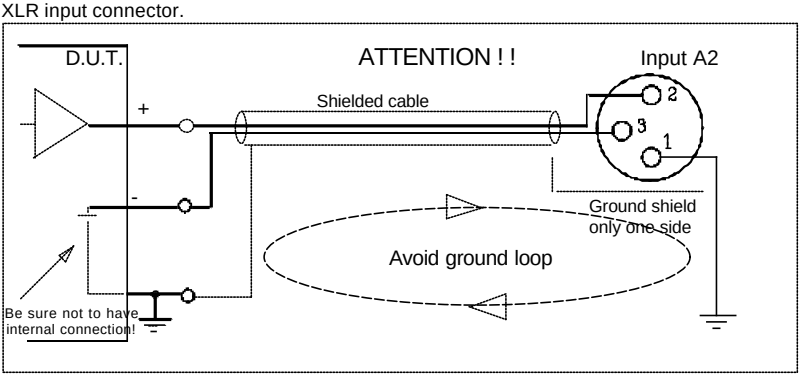
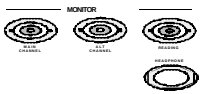


Fig. 6 Unbalanced Connection to the A2/A2-D

NOTE Never c onnect pin 1 and pin 3 together as long as you are not absolutely sure, that the GND output of the DUT is galvanically isolated from earth. If in doubt, leave pin 1 of the A2/A2-D unconnected to avoid earth loops.

Monitor Outputs

There are three BNC connectors and one headphone jack in the *MONITOR* section on the rear panel, providing monitor signals for further processing. Output impedance through the headphone connector is ~68Ω, while the BNC connectors have an impedance of 600Ω.



The two connectors *MAIN CHANNEL* and *ALT CHANNEL* offer the signals of each input channel right behind the input amplifiers. The level of these signals are always around 1V (0dBV).

The third BNC output offers the *READING* signal, which is the analogue signal of the MAIN channel after all the filtering and weighting, but before its rectification (see ***Input Block Diagram***).
Please notice, that the signal provided at the *READING* output is not necessarily the same as at the two other connectors. Depending on the actual measurement function, the character of the *READING* signal will be totally different from the two other outputs (e.g. with measurement function THD + N or IMD). More detailed information about this topic are given in the respective chapters describing the measurement functions.

> ***NOTE The MONITOR outputs are not calibrated and shall not be used for measurements.***

Monitor Loudspeaker

The *READING* signal is also fed to the internal loudspeaker. The volume can be changed through the potentiometer on the front panel, marked with the loudspeaker sign.

Overview

- The input impedances may be selected through the <IMPEDANCE> key.
- The unit may be operated in the balanced or unbalanced mode, by setting the <FLOAT GND> switch on the rear panel accordingly.
- Double-clicking to the <A / B> key opens a menu to select either *Auto* or *Fixed* ranging.
- The monitor speaker reflects input signal after the input stage and filtering. Its volume can be controlled through the potentiometer on the front panel.
- The *READING* output monitors the input signal after the input and filter stage.
- The *MAIN CHANNEL* and *ALT CHANNEL* connectors provide the normalized, but unweighted input signals.

Output Section

The A2/A2-D is equipped with a versatile digital generator, providing optimum performance with maximum flexibility to supply the device under test with purest signals.

The most important features of the generator are

- Output level -100dBV to +27.6dBV (10µV-24.5V_{RMS})
- Frequency range 10Hz-100kHz
- Selectable output impedances <15Ω to 600Ω
- Seven different signal waveforms
  - Very pure sine signal with typical THD+N < -91dB (<0.001%)
  - Warbled sine signal
  - IMD signal according to SMPTE and DIN
  - Squarewave (duty cycle 50/50 or 40/60)
  - W&F signal according to IEC and NAB
  - White noise
  - Pink noise
- Fast parameter setup through function keys and softwheels
- Individual mute function for each channel
- Sweep capability over the entire frequency & level range

Output Circuit

The diagram below shows the simplified diagram of the A2 output stage.

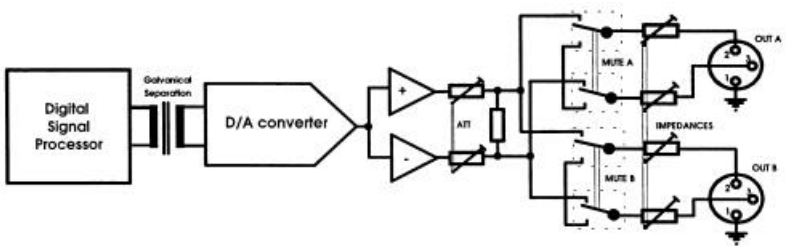


Fig. 7 Generator Block Diagram

All output signals are generated by the internal Digital Signal Processor of the A2/A2-D. In order to isolate the generator from the analyzer circuitry, optocouplers were inserted between the DSP output and the D/A converter. The analog signal is filtered and fed into the balanced output amplifier. Behind this stage, an attenuator selects the level range of the output signal. The signal is then split to the two output channels and fed through the mute relays. The output impedances are wired behind these mute relays.

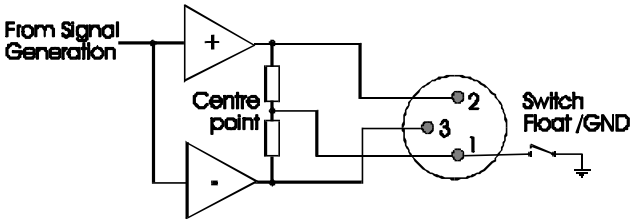
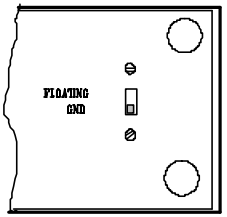


Fig. 8 Output Wiring

Pin 1 of each XLR output connector represents the center potential between pin 2 (+signal) and pin 3 (-signal). It can either be kept *floating* or be connected to the chassis *ground*. In general, it is recommended to operate the A2/A2-D in the *FLOATING* mode in order to avoid ground loops.



The <FLOATING / GND> switch is located on the rear panel of the A2/A2-D.

- *FLOATING* disconnects pin 1 from chassis ground, i.e. the reference potential of the output amplifiers is floating.
- *GND* links the reference potential of the output amplifiers to chassis ground.

Balanced Operation

Normally, the A2/A2-D is operated in the balanced (symmetric) mode. In this case, the device under test (DUT) is connected to the two hot pins 2 (+signal) and 3 (-signal) of the generator output stage.

NOTE If working with a balanced load, it is recommended to operate the unit in the FLOATING mode.

Unbalanced Operation

When driving an unbalanced device, it is recommended to connect pin 2 (+signal) of the output stage to the hot input connector of the DUT, and to link pin 3 (-signal) of the output stage with the ground of the DUT. In this case, operate the A2/A2-D in the *FLOATING* mode. By this way only, the loss of half of the output level can beavoided.

On the other hand, unbalanced loads may also be connected between pin 2 (or pin 3) and pin 1 of the A2/A2-D output stage (half side connection). In this mode, it is recommended to set the switch on the rear panel to *GND* in order to get an invariant reference potential.

Optional Transformer Output Stage

Some applications require a complete galvanic separation between the generator output connectors and the device under test. For this purpose, a transformer option is available (article code AO7), that adds a high quality Audio transformer behind the power amplifier of the A2/A2-D.

The A2/A2-D generator specifications as well as the output impedance circuitry are the same with and without the transformer option. Please refer to chapter ***8. Instrument Setup*** for further details.

Output Settings

The METER display mode provides the best overview on the generator settings and measurement results. Therefore, it is recommended to enter this mode when reading through this chapter.

Output Parameters

The generator frequency, output level, waveform and output impedance are continuously displayed on the upper two lines of the LC display.

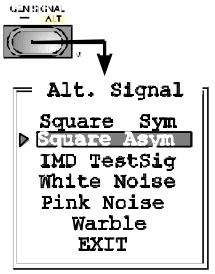
The top line shows in large characters the set generator frequency and level. In the second line, the selected output impedance and waveform are indicated, as well the actual output voltage (*readback* value) or the input impedance of the device under test (please refer to chapter ***Readback*** for more detailed information).

Signal Waveform

The <GEN SIGNAL> key allows to select the signal waveform to be generated. It will have either the ~ (sine) or the ALT symbol illuminated from behind by a green LED. To toggle the setting, simply push the button once.

- In the ~ mode, the generator output will be a pure sine signal.
- In the *ALT* mode, the actually selected alternate signal is active.

The A2/A2-D digital generator offers a wide range of alternate signals. To make one of them the active signal, double-click on the <GEN SIGNAL> key. This opens the *Alt Signal* menu, showing the list of available alternate signals.



The active signal is displayed inverted (white characters on a black background). To change the selection, move the arrow on the left-hand side through the <SCALE> softwheel to the alternate signal you wish to select and press the <SCALE> wheel once.
Consequently, the actual selection of the alternate signal will change accordingly, i.e. the new signal will become active, and the menu will close automatically.

Alternatively, selection of the *EXIT* entry or any keypress to the A2/A2-D keyboard will leave the menu without a change of the actual setting.

***NOTE** In some measurement functions like IMD and W&F, a predefined waveform - depending on the selected standard - is activated as alternate signal.*

Therefore, activation of the "Alt. Signal" menu will show this setting. Although it is possible in this state to alter the signal in the menu, it will be re-set automatically to the predefined waveform as soon as the menu is closed.

Square Signal (Sym. / Asym.)

The *Square Sym.* and *Square Asym.* are squarewave signals with either a duty cycle of 50/50 (sym) or 40/60 (asym). Regardless of the duty cycle, the squarewave signal has the actually selected frequency and level, calibrated in true V_{RMS}.
A typical application for the 40/60 signal may be for quickly checking the polarity of lines.

IMD TestSig

The IMD test signal consists of two signals components,

- a sinewave with a fixed frequency of 60Hz or 250Hz, *and*
- a second sinewave with a frequency of at least 4kHz, that may be set through the <FREQUENCY> softwheel.

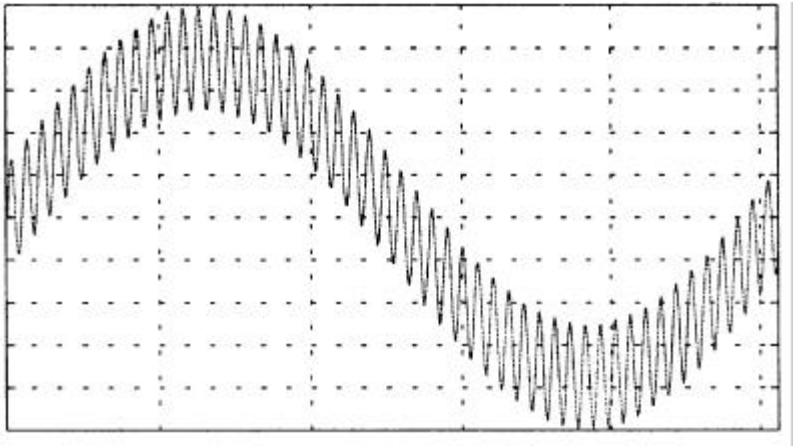


Fig. 9 IMD Testsignal

The level ratio between the low- and the high-frequency component is either 1:1, 4:1 or 10:1 (refer to chapter ***5. Measurement Functions***). Consequently, there are six different IMD test signals available (according to the SMPTE and DIN standards). To define one of them as default signal, the *IMD Default* menu must be opened by a double-click on the <IMD> key.

In normal operation, the *IMD TestSig* will be activated automatically as soon as the IMD measurement function has been entered. Alternatively, it may also be activated manually through the *Alt. Signal* menu.

Noise

The generator of the A2/A2-D offers *White* and *Pink Noise*, both with a bandwidth being limited to 20kHz, in order to maximize the energy falling into the Audio band.

- The characteristic of *White Noise* is a constant energy density for all frequency bands with identical width (e.g. width = 100Hz). Consequently, the noise spectrum will show a **constant** amplitude (energy) if analyzed vs. the **linear** frequency axis, or a linear rise of 10dB/decade if plotted vs. the logarithmic frequency axis.
- On the other hand, the amplitude of *Pink Noise* shows a **linear decay** of 10dB/decade if analyzed vs. the **linear** frequency axis, or a constant amplitude if plotted vs. the logarithmic frequency axis.

> ***NOTE*** ***Pink Noise has a very high Crest factor, i.e. a high Vp / V_{RMS} level ratio. Therefore, it is typical for Pink Noise that its amplitude, measured Quasi-Peak or RMS, is never stable.***

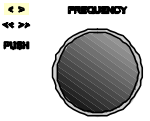
Warbled Sine

The *Warble* signal is a sinusoidal signal with oscillating frequency. The active generator frequency defines the center frequency, while the modulating signal has a triangular shape with 4Hz. The Warble signal is best described in the frequency range, showing a fixed amplitude that oscillates with about 4Hz and a 3rd-octave bandwidth around the center frequency, set with the <FREQUENCY> softwheel.

Frequency

The generator output frequency is set through the <FREQUENCY> softwheel. This wheel has no end stops. Turning it counter-clockwise reduces the frequency or clockwise to increase the frequency. The limits of 10Hz and 100kHz cannot be exceeded.

> ***NOTE*** ***In some measurement functions the frequency range is reduced to a smaller bandwidth. Refer to the corresponding measurement function to see the exact limits.***

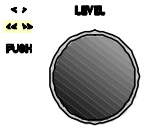


The frequency is not controlled in a continuous fashion - like with an analog generator controlled by a potentiometer - but in discrete steps. Pushing the wheel exchanges the step size between *coarse* (« ») and *fine* (< >). The selected step size is indicated by an active LED behind the respective sign.

- A **slow** (i.e. stepwise) turn of the softwheel change the output frequency by *1/6-octave* steps in the *coarse* mode, or 0.5% steps in the fine mode
- A **fast** turn in the *coarse* mode changes generator frequency *to 20Hz, 100Hz, 1kHz, 10kHz, 40kHz, 100kHz*, while in the fine mode, each fast turn causes the generator to jump in 3rd- octave steps.

Level

The generator level is controlled through the <LEVEL> softwheel.



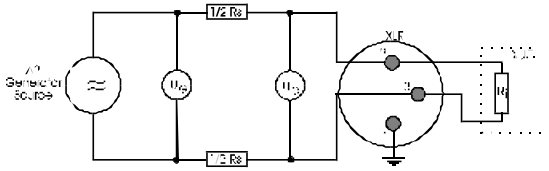
Like the output frequency, also the generator level is controlled in discrete steps of 2dB (coarse) or 0.05dB (fine).

Please notice, that the absolute limits of +30dBu (27.7dBV / 24.49V) and -97.7dBu (-100dBV / 10µV) cannot be exceeded.

- A fast turn of the <LEVEL> wheel in the *coarse* mode causes the generator to jump by *20dB* to even values ([dBu] or [dBV] selected), or to the next decade ([V] selected).
- A fast turn in the fine mode forces the generator to jump jump by 2dB to even values, or with an increment of 1V.

Readback

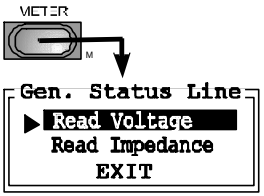
In case that the input impedance of the device under test is relatively low, a major output voltage drop on the A2/A2-D may occur. Actually, the output voltage U_O may be calculated according to following formula.



$$U_0 = U_G * \frac{R_i}{R_i + R_s} \quad \rightarrow \quad R_i = \frac{U_0 * R_s}{U_G - U_0}$$

Obviously, it may happen that the generator voltage U_G (set by the <LEVEL> wheel) differs from the actual output voltage U_O at XLR connectors.
In order to detect such cases, the A2/A2-D is equipped with the *Readback* function, that measures the true voltage U_O between pin 2 and pin 3 of both output channels, independently from the active analyzer function.

The readback measurement reuslts are displayed on right hand side of the status line in the METER display mode. Alternatively, it is possible to show the *load impedance* R_i of the device under test with an accuracy of 5% + 1Ω.



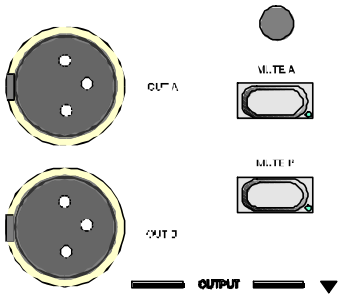
To select whether the readback voltage or the load impedance of the DUT shall be displayed, open the *Gen. Status Line* menu by double-clicking on the <METER> button.
Next, make your selection by turning the <SCALE> softwheel to the respoective position and pushing the wheel once.

NOTE The reading of the load impedance is most accurate if the selected source impedance is closest to the displayed load impedance.

Consequently, the displayed values of the second line in the METER panel can be summarized as follows.

1. The selected output impedance
2. The actual waveform
3. The true output level / input impedance of the DUT of both channels.

Output Muting



On the right hand side of the output connectors are the <MUTE> buttons, that allow to switch Off the generator signal.
If activated, the mute function internally disconnects the generator from the output connector and inserts a short circuit behind the impedances (see also ***Fig. 7***). Muted outputs result in a very quiet output, being properly terminated with the selected impedance.
This feature simplifies output measurements of a DUT, that is not stimulated with any signal, by making the physical disconnection of the generator obsolete.

Overview

- The generator outputs may be operated either balanced or unbalanced.
- The selectable output signal parameters are the waveform, frequency and level.
- To set the output impedance, use the <IMPEDANCE> menu / key.
- In the METER mode, the output voltage or impedance may be displayed.
- The generator outputs may be mutes by pressing the respective <MUTE> keys.

Display Modes

Depending on the type of information you need, the A2/A2-D offers three different display modes.

- The METER panel for single measurements
- the GRAPH mode for sweep recordings and
- the SCOPE mode to watch the time signal.

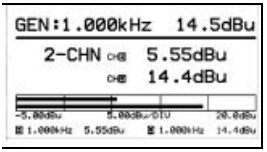


Fig. 10 METER Mode

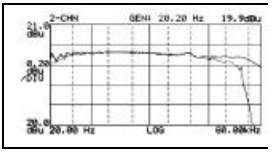


Fig. 11 GRAPH Mode

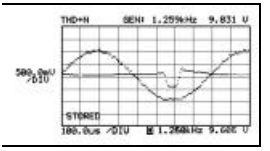


Fig. 12 SCOPE Mode

> ***NOTE*** ***Regardless of the active measurement (including sweeps), it is always possible to switch to any other display mode without compromising the accuracy of the measurement.***

METER Display Mode

This display mode is entered by pressing the <METER> key once. It provides all the necessary information and results of the selected measurement task and all related information which may further help to qualify your measurements. The top line(s) always contains the generator parameters and the bottom line is reserved for the input parameters.

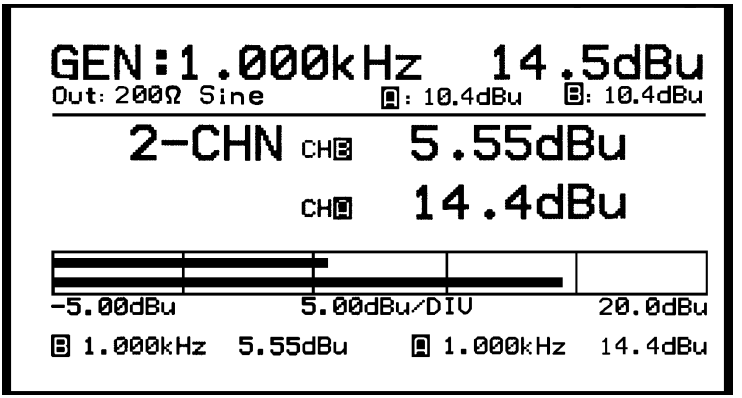


Fig. 13 METER Panel

Please notice, that the METER display will automatically change its layout for all 1-channel measurement, by showing the single measurement result in large letters instead of the two lines of the 2-channel Level result.

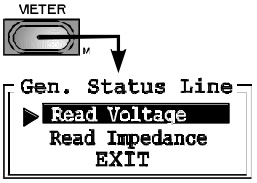
Generator Settings

The selected generator output voltage (nominal value) and frequency are always displayed on the top of the METER display.
The unit, in which the frequency is expressed, cannot be influenced by the operator, while the unit of the generator output voltage is the same as selected for the Level measurement results. Please refer to chapter ***Output Section*** / ***Output Parameters*** for more details about the generator settings.

> ***NOTE*** ***If the generator signal is set to White or Pink Noise, the frequency of the generator is still displayed, although a noise signal obviously has no frequency.***
>
> ***However, the assignment of a generator frequency is necessary to set the tunable notch-filter of the A2/A2-D to the desired frequency.***

Generator Readback

In case of a relatively low input impedance of the device under test (DUT), the true output voltage of the A2/A2-D generator may be lower than the selected and displayed nominal level.
Therefore, an additional readback reading of the true output voltage, or, alternatively, of the input impedance of the DUT is permanently displayed. Please refer to chapter ***Output Section*** / ***Readback*** for further details.



Open the *Gen. Status Line* menu by double-clicking to the <METER> key. Therein, one may toggle the display between the readback voltage and the load impedance of the DUT by using the <SCALE> softwheel.

Please note that in measurement function IMD the readback feature is disabled.

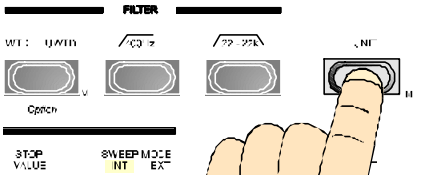
Measurement Results

The results of the selected measurement function are displayed in both numerical and analog form through large digits and a bar-graph below. In the 2-channel Level measurement mode, two lines of both display forms are placed on top of each other.
All measurements results - except of noise - are true RMS values. Noise is measured quasi-peak according to the CCIR-468-3 standard.

> ***NOTE*** ***The input and the readback voltage are always RMS values, independent of the selected measurement function.***

Units

The unit, in which the result shall be expressed, can be selected by pressing the <UNIT> button on the right hand side of the front panel.



Each keypress steps to the next available unit.

If there are no alternative units (e.g. with measurement function W&F), presing the unit button has no effect.

NOTE ***The <UNIT> button influences the unit of the measurement result only, i.e. not the generator level unit, except of measurement functions LEVEL and 2-Channel, where the units are coupled together.***

The Bar-graph

The bar-graph displays the measurement result in an analog way. This makes the bar-graph very helpful to identify trends and tendencies of changing / unstable signals, or when doing adjustments to minimize / maximize a signal.
Normally, in the AUTO mode, the bar-graph is scaling automatically, but its scale can be zoomed and scrolled to any point in the measuring scale manually.

Zooming the Bar-graph Scale

The <SCALE> softwheel provides the possibility to adjust the bar-graph scale exactly to your needs. To enter the ZOOM mode, push the <SCALE> wheel once. Each further push to the <SCALE> wheel will toggle between ZOOM and SCROLL mode. To return to the AUTO mode, double-click on the wheel.

- In the ZOOM mode, every *CW* incremental step of the <SCALE> wheel *increases* the sensitivity (units/division) of the bar-graph.
- A *CCW* increment *decreases* the sensitivity, i.e. it enlarges the displayed range.
- A *fast* turn of the <SCALE> wheel in the CW / CCW direction sets the scale of the bar-graph to the highest / lowest sensitivity respectively.

If the bar-graph is zoomed, the center value is kept constant if possible (symmetric zooming). However, in case that the value 0 (zero) would fall into the scale, it is shifted to the left border value of the new scale.

Scrolling the Bar-graph

The SCROLL mode may be entered by pushing the <SCALE> softwheel once from the ZOOM mode, or twice (slowly, no double-click!) from the AUTO mode. It allows to scroll the visible range of the bar-graph scale through the availbale range.

- Every incremental step of the <SCALE> wheel in *CW* direction moves the visible part of the bar-graph to the *right* by one division.
- On the other hand, a CCW increment moves the visible part of the bargraph to the *left*.

To quickly locate the range, where the signal is located in the bar-graph, make a fast turn of the <SCALE> wheel in CW or CCW direction. This acts like a beam finder. Turn CCW if the signal is 'larger' than the displayed scale, or CW if no signal is visible at all.

To set the scaling function back to AUTO mode, push the <SCALE> wheel twice quickly. The actually selected mode (AUTO, ZOOM or SCROLL) is always indicated by a LED behind the respective label.

Input Display

On the bottom end of the METER display, additional information about the input signals are available. The displayed values show the input voltage and frequency, measured right behind the input connectors. If the 2-channel Level function is used, frequency and level of both input channels are shown, while the parameters of the active channel, together with the input impedance of the analyzer, are shown with all single channel functions.

This Input display is very helpful for all non-Level measurement functions (e.g. THD+N, IMD, Noise etc.), that do not display the input signal level. For instance, in the IMD measurement mode, it is important to know the frequency and level of the input signal to allow the proper interpretation of the IMD results. Therefore, this information is shown on the Input display.

In case that the incoming signal is too small or too noisy to be measured, no frequency / level values are displayed.

> ***NOTE*** ***The input level results are always RMS values, regardless of the selected measurement function. The measuring bandwidth is 500kHz, without any weighting filter being involved.***

Printouts

The METER Display display can be printed out to a printer by pressing the <PRINT> button. The printout contains all relevant information to document the measurement result.

```
--------------------|-------------------------|-----------|----------------
Output  Imp: <15Ohm | Input     Imp: 100kOhm  | Filter:   | LEVEL
Sine                |                         | Off       |
1.000 V  / 1.000kHz | A: 775.6 mV /  1.000kHz |           |    775.6 mV
--------------------|-------------------------|-----------|----------------
```

Fig. 14 Example of a METER Display Printout

GRAPH Display Mode

Apart from the ability to measure and display single results, the A2/A2-D offers a big variety of sweeps (sweep = sequence of measurements, plotted vs. the variation of one parameter) as well. The GRAPH display mode supports best the definition of the sweep setup and allows to show the recorded curves.

The available sweep modes of the A2/A2-D are

- Internally controlled frequency sweeps
- Externally controlled frequency sweeps
- Amplitude sweeps
- Time sweeps
- Table sweeps

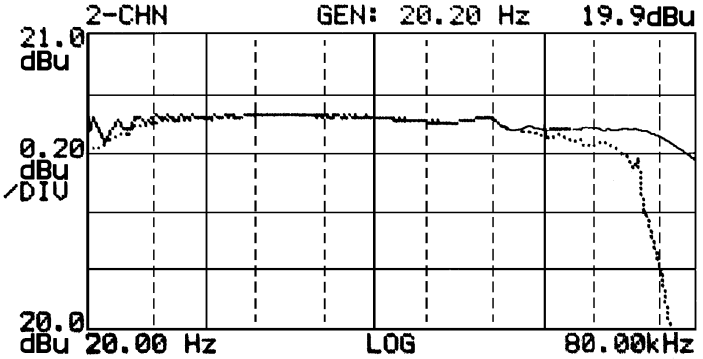


Fig. 15 GRAPH Display Example

The A2/A2-D2 comprises an curve tracer feature, that automatically controls and displays the selected sweep type. It is able to record up to 6 sweep curves in one graph, depending on the resolution, thus allowing their comparison. Furthermore, 4 complete graphs may be stored in the internal memory of the A2/A2-D. They remein stored even after power Off, and can be recalled at any time to be printed out or for additional sweep curve recordings.

The running and the fixed generator parameters are displayed on top of the GRAPH display, together with the selected measurement function. The scaling of the Y-axis may be done either manually or automatically by the A2/A2-D.

The unit of the measurement function (Y-axis) may be selected through the <UNIT> button. Each press to this key steps through the available units.

***NOTE** When changing the unit, the A2/A2-D does not repeat the sweep measurements, but re-calculates the recorded traces (even during a running sweep recording). This allows for example a quick conversion from any linear scale to a logarithmic scale and vice versa.*

Cursor Function

After having recorded a Frequency-, Amplitude-, or Table-sweep, it is possible to activate a cursor to read out the individual measurement results of the curve. This allows to display all result pairs, that are part of a sweep curve.

In practice, the <FREQUENCY> / <LEVEL> softwheel respectively allow to control the position of the cursor.

- To activate the cursor in a *Frequency* or *Table* sweep, simply set generator frequency into the range of the recorded sweep (X-axis) by using the <FREQUENCY> softwheel. Consequently, a crosshair becomes visible in the graph, representing the cursor. On the bottom line of the graph, the frequency & measurement function results, corresponding to the position of the crosshair, are displayed in inverse letters (white on black).
- For *Amplitude* sweeps, the cursor is available by setting the generator level into the range of the recorded sweep (X-axis) by using the <LEVEL> softwheel. Again, the numerical values, that correspond to the position of the cursor, are displayed in inverse letters on the bottom line of the graph.

The cursor will disappear as soon as the upper or lower end of the X-axis is reached and reappears as soon as the generator frequency / level returns into the recorde range of the sweep (X-axis).

To take full advantage of the Cursor feature, please notice the following.

- The <FREQUENCY> / <LEVEL> softwheel may be operated in either *fine* (< >) or *coarse* (« ») mode.
- If the cursor is placed between two actually recorded measurements, the displayed values will be interpolated linearly.
- It is possible to enter the METER display and return to the GRAPH display at any time - also during a running sweep - without loosing any information.
- The cursor will not beprinted out together with the graph.
- In the *Time*-sweep mode, there is no cursor function available.

Y-Scaling

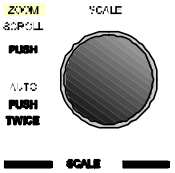
The <SCALE> softwheel gives you the possibility to adjust the scaling of the Y-axis in the GRAPH mode according to your needs.

- In the AUTO mode, the A2/A2-D calculates the optimum scaling out of the valid measurements from all the traces within the graph.
- The ZOOM mode allows to manually adjust the sensitivity of the graph.
- The SCROLL mode allows to scroll the displayed graph through the avilable range.

To leave the AUTO mode, push the <SCALE> wheel once. Each further push will toggle between the ZOOM and SCROLL mode. To set the SCALE function back to AUTO mode, push the <SCALE> wheel twice quickly. The selected mode is always indicated by a LED behind the label.
Every change of the scaling mode (AUTO, ZOOM or SCROLL) re-draws the recorded traces completely in the new scale, without loosing any information.

ZOOM

The ZOOM mode allows to enlarge / reduce the scaling (units per division) of the Y-axis by turning the <SCALE> sofwheel in clockwise (CW) / counter-clockwise (CCW) direction.



- Every incremental step in CW direction of the <SCALE> wheel increases the sensitivity of the Y-scale.
- A CCW increment decreases the sensitivity, i.e. enlarges the displayed range of the Y-axis.

The actual sensitivity is displayed on the left hand side of the graph. Every zooming keeps the centre value of the Y-axis at its place, if possible. In case that the 0 (zero) value would fall into the scale, the range will be scrolled upwards, so that the zero value corresponds to the bottom line of the graph.

NOTE A fast turn of the <SCALE> wheel in the ZOOM mode reduces (CW turn) or expands (CCW turn) the Y-scaling to the Min / Max sensitivity

SCROLL

The SCROLL mode allows to scroll the range of the Y-axis scale upwards / downwards by turning the <SCALE> sofwheel in clockwise (CW) / counter-clockwise (CCW) direction.

- Every incremental step of the <SCALE> wheel in CW direction moves the visible range down by one division.
- A CCW increment of the <SCALE> wheel lowers the curve by one division.

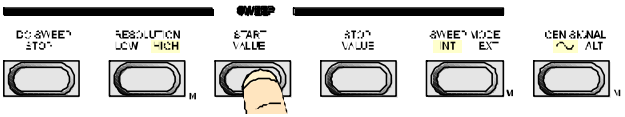
The borders of the actual range (Min & Max values) are always displayed on the left hand side of the graph.

NOTE A fast turn of the <SCALE> wheel in the SCROLL mode acts like a beam-finder, i.e. lets the A2/A2-D display any recorded curve, that is located either below (CW turn) or above (CCW turn) of the actual position.

X-Scaling

After having recorded a sweep, the scaling of the X-axis (Min / Max values) may be changed. To do this, set the parameter of the X-axis by turning the corresponding softwheel to the desired value, and press the <START VALUE> / >STOP VALUE> key respectively.

- In a recorded *Frequency* sweep, use the <FREQUENCY> softwheel
- In a recorded *Amplitude* sweep, use the <LEVEL> softwheel



Consequently, the graph and all recorded curves are re-drawn automatically in the new range. In other terms, the curves are not measured again, but fitted into the new graph. Refer also to chapter ***6. Sweeps*** for more information.

GRAPH Printouts

Any graph may be printed out to a connected printer by pressing the <PRINT> button, which is located on the right hand side of the front panel. Consequently, the complete graph including all curves, the grid and the scaling will be printed.

To select the printer driver, double-click on the <PRINT> key and choose from the menu that will open. Details about the printers and its selection are given in chapter ***7. Printouts***.

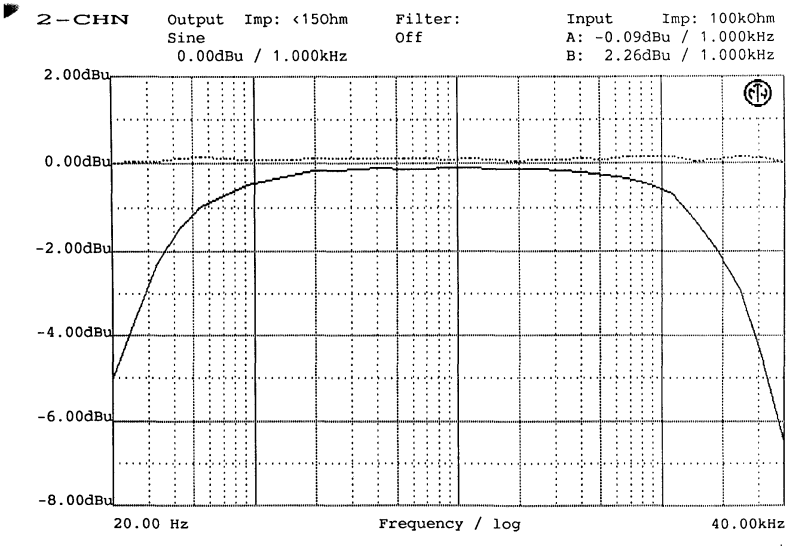


Fig. 16 Example of a Printed GRAPH Display

The A2/A2-D is not blocked during the print-out. The print process is handled in the background so that any measurement may be performed or continued in the meantime.

Store & Recall Graphs

Sometimes, when using the A2/A2-D, no printer may be available for documentation. Therefore, to allow later printouts of recorded graphs, the A2/A2-D offers four memory locations to store and recall a complete graphs in each of them, with all the curves and the scaling included. This memory is battery backed-up to allow to disconnect the instrument from mains power and to return to the office for the print-out. The detailed description on how to store and recall graphs is described in chapter ***6. Sweeps***.

SCOPE Display Mode

The SCOPE mode extends the set of A2/A2-D tools by offering a simple audio oscilloscope, that lets the operator analyze the waveform of the input signal(s) in the time domain.

To enter the SCOPE mode, simply push the <SCOPE> button. Consequently, the LC display will change to the oscilloscope mode and show the input signal(s) vs. the time axis.

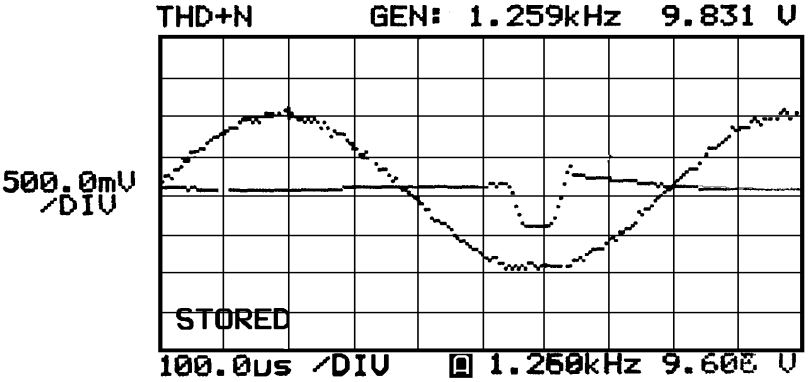


Fig. 17 SCOPE Display Example

On top of the LCD, the generator level and frequency are indicated like in the other display modes. Below, the waveform(s) are plotted, whereof the A2/A2-D automatically determines the scaling of the Y- (measurement function) and X- (time) axis, i.e. there is no possibility to set the scaling manually.

- Both resolutions are displayed next to the corresponding axis to allow to read out accurately the amplitude and period. Minimum time resolution is 10µs per division.
- If possible, the auto scaling displays one period of the signal. This ensures, that the operator can qualify the waveform of the input signal without the need to modify the settings.

In the *2-channel Level* mode, the sensitivity of the Y-axis is identical for both channels and determined by the level of the active (main) channel. Optimized scaling for the alternate channel can be obtained by making it the active channel (push the <A / B> key). Both in the *2-channel Level* and *Phase* measurement function, the two input signals are shown in a true phase position.

In the *THD+N* function, there are also two traces displayed: the smaller one is the distortion residual after filtering out of the fundamental frequency, while the larger trace shows the unfiltered input signal.
Both traces are synchronized, to enable inspection of where the distortion is occurring. Beware though, due to the phase shift of the notchfilter which removes the fundamental frequency, that the distortion products cannot be exactly synchronized. This effect is worst with the second harmonic.

In the *Noise* measurement function, the SCOPE mode is blocked in a way, that the A2/A2-D automatically switches its display to the METER mode.

NOTE The SCOPE mode is blocked in measurement function Noise, by switching the A2/A2-D display automatically to the METER mode.

This is because there would be no signal, but some flickering dots visible only.

The display can also be frozen to analyze moving signals by a second push to the <SCOPE> button. The message *STORED* is then displayed to indicate the frozen state. Another push to the <SCOPE> button releases this state.

Printouts

Like all other display modes, the SCOPE display can be printed out to a Printer by pressing the <PRINT> key. During the print-out, the A2/A2-D automatically freezes the scope screen. The operator can release this freezing mode by a double-press to the <SCOPE> button to watch the trace even during the print-out, but with the side-effect of a slower print-out. In the THD+N mode, only the residual is printed out.

See also chapter ***7. Printouts*** for details about printer settings.

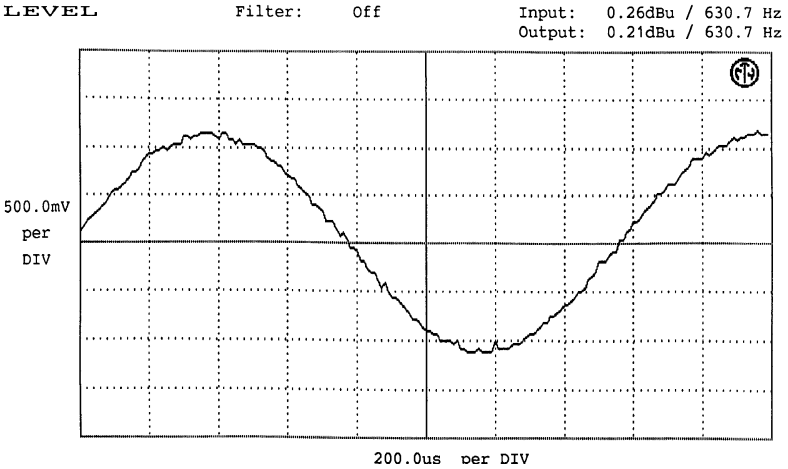


Fig. 18 Example of a Printout in the SCOPE mode

Overview

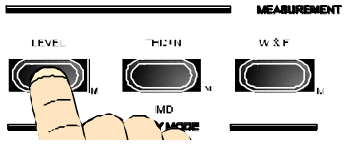
- The SCOPE screen displays the waveform of the input signal(s) in the time domain.
- The scaling of the X- & Y-axis are set automatically, i.e. cannot be changed manually.
- In the THD+N measurement function, the unfiltered input signal as well as the distortion residual are displayed simultaneously.
- If the Noise measurement function is active, the SCOPE mode is not available.

5. MEASUREMENT FUNCTIONS

Level Function

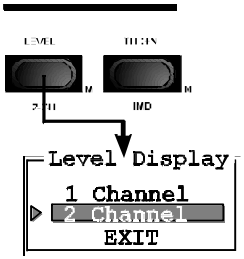
The Level measurement function allows to perform an absolute level (amplitude) measurement in true RMS[1] for either one channel, or two channels simultaneously. After having passed the input amplifier / attenuator stage, the input signal is rectified by the true RMS detector and A/D converted for further analysis. Additionally, several filters may be introduced into this path, in order to further weight the signal. Please refer also to the block diagram shown in ***Fig. 4***.

The bandwidth of the A2/A2-D analyzer is limited to 2Hz-250kHz, while the allowed input level ranges from 1µV to 200V_{RMS}.



To enter the Level measurement function, make sure, that no sweep is running and press the <LEVEL> key.
Consequently, the A2/A2-D will show the measured input level(s) on its LCD. Should the display show L.REL then press the <LEVEL> key once again to enter the (absolute) level measurement mode labeled *2-CH* or *LEVEL*.

Mono / Stereo Measurements



The <LEVEL> key hides the *Level Display* menu that allows the operator to choose between 2-channel (stereo) or single-channel (mono) level analysis.

This menu can be opened by a double-click to the <LEVEL> button. Use the <SCALE> wheel to move the arrow to the required mode (1 / 2 Channel). A push to the <SCALE> wheel activates the selection while any other key leaves the menu without a change.

The bottom line of the METER display shows the RMS level(s) and the frequency of both input channels A and B, measured right behind the input connectors, i.e. the not-filtered input signal(s). Please refer to chapter ***Input Display*** for further information.

Units

The A2/A2-D provides the possibility to express the Level measurement results in several units. The linear unit [V] represents the absolute input voltage, measured against the 0V reference potential (GND).
On the other hand, the dB*x* units express the input voltage in a logarithmic scale vs. different reference voltages.

Each of these units can be converted into any other by one of the mathematical equations, listed in ***Table 2***.

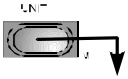
[1] RMS= Root Mean Square. This is the energy equivalent value of the signal.

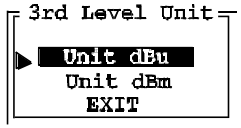
Unit	lin/log	Reference	Calculation
V	lin	ISO unit	-
dBV	log	1.000V	$20 \cdot \log(\frac{U[V]}{1.000V})$
dBu	log	0.7746V	$20 \cdot \log(\frac{U[V]}{0.7746V})$
dBm[2]	log	1mW	$20 \cdot \log(\frac{U[V]}{\sqrt{1mW \cdot R_L[\Omega]}})$

Table 2 Level Unit Conversions

NOTE The unit dBm in the LEVEL functions is handled as the dBu unit, assuming a load impedance of 600 W

To alter the selected unit, simply press the <UNIT> button. Each press changes to the next unit available in that function.





To toggle between the dBm and the dBu unit, open the *3rd Level Unit* menu behind the <UNIT> button by double clicking to it in the measurement function Level.

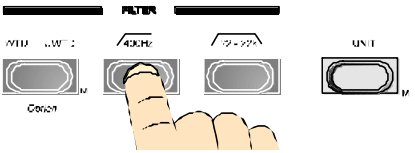
Select the unit of your convenience with the <SCALE> wheel and confirm by pushing to it. The menu closes automatically after the selection. Leave it through the *EXIT* entry or by pressing any key in case that no change is required.

Please notice, that the *generator level unit* is coupled to the *level measurement unit* in measurement function Level only. Therefore, in order to change the generator unit, it is necessary to enter the Level measurement function and to select the required unit.

Filters

The A2/A2-D has two frequently used filters built-in as a standard. The 400Hz highpass and the 22Hz-22kHz Audio bandpass filter. Both filters are built by a 3rd order stage with an edge steepness of 60 dB/decade.

To activate one or both of these filters at a time, press the /400Hz or the /22-22k\ key respectively.



[2] Although the definition of dBm is a power and not a voltage, it is mostly handled as a voltage, equal to the dBu, representing the power into a 600Ω load.

Furthermore, the A2/A2-D is prepared to handle one or two additional weighting filters per channel for Level measurements. Following filter options are available.

- A-weighting filter (order code AO4)
- User-definable filter (order code AO5)
- C-message filter (order code AO13)
- 80kHz lowpass filter (order code AO14)

To activate the additionally installed filter(s), i.e. to insert it into the signal path, press the <WTD UWTD> button. If a filter is installed, the LED behind the WTD will light up, indicating that filter #1 is active.
If a second filter is installed on the same channel, the next keypress to the <WTD UWTD> key will remove filter #1 from the signal path, but activate filter #2 and light up the LED behind UWTD.
A third press to the <WTD UWTD> button deactivates both LEDs, indicating that no more weighting filter is active.

If only one additional filter is installed, the UWTD position is not available; the <WTD UWTD> key will in this case toggle between WTD and Off.

> ***NOTE The optional filters are handled exclusively; if they are activated, they automatically switch Off any other active filter.***

Applications

The LEVEL measurement is the most widely used measurement function in the Audio field. It is useful to

- Check the signal level
- Line up tape machines
- Calculate the output impedance of a DUT out of the level over a certain impedance
- Measure the frequency response
- Measure the balance between two channels
- Calculate the power from the level over a certain impedance

To learn more about how to measure a frequency response, read chapter ***6. Sweeps***.

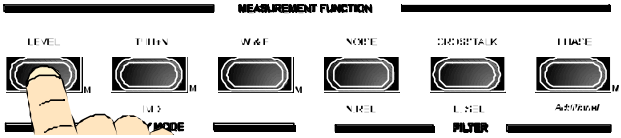
Overview

- The A2/A2-D analyzer provides a bandwidth of 2Hz-250kHz in the Level mode
- The menu behind the <LEVEL> key allows to set the unit to either between 1-chn. (mono) or 2-chn. (stereo) measurements.
- All standard frequency weighting filters as well as installed filter options may be activated.
- The unit of the generator output level may be altered in the Level measurement mode only.

Level Relative Function

The Level Relative function is an extension of the (absolute) Level measurement function, allowing to change the reference voltage for the Level measurement, i.e. to measure the input level relatively to a user-defined reference.

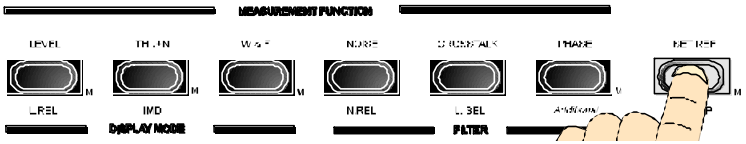
To activate the Level Relative measurement function, make sure that no sweep is currently running, enter the Level mode and press the <LEVEL> key a second time.



> ***NOTE*** ***Every push to the <LEVEL> keys toggles between the two measurement functions Level and Level Relative.***

As soon as you have activated the Level Relative mode, *L. REL* will be displayed on the LCD, and the A2/A2-D analyzer will immediately show the actual result. On the bottom line of the METER display, the absolute input level and frequency of the active channel, as well as the *current reference level* are indicated. All Level Relative measurements are made against this reference.

To set or change this reference value, apply the reference voltage you require to the active input channel and press the <SET REF> key on the upper right corner of the front panel.



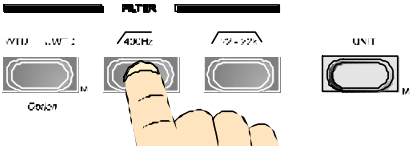
The new reference level will be active and displayed immediately on the bottom line of the METER display.

Keep in mind that the generator level, displayed continuously in the top line of the display, is always measured in absolute terms.

Filters

For the Level Relative function, the Audio bandpass 22.4Hz-22.4kHz as well as the 400Hz highpass filter are available in any combination.

Furthermore, all installed optional weighting filters can be activated as well. Select the filters by pressing the corresponding key.



Units

As with the absolute Level function, several units are available for Level Relative measurements. They can be selected through the <UNIT> button. Each press toggles to the next available unit.

Unit	*lin/log*	*Reference*	*Calculation*
%	lin	U_{REF}	$\frac{U[V]}{U_{REF}[V]} \cdot 100$
*1	lin	U_{REF}	$\frac{U[V]}{U_{REF}[V]}$
dBr	log	U_{REF}	$20 \cdot \log(\frac{U[V]}{U_{REF}[V]})$ or $U[dB] - U_{REF}[dB]$

Table 3 Level Relative Units

Application Example

To measure the channel balance in a stereo equipment proceed as follows

1. Apply the signals to the inputs of the A2, e.g. left chn. to input A, right chn. to input B.
2. Select with the <A / B> key the reference channel which is usually left, e.g. input A.
3. Push the <SET REF> button, then make the other input channel the active one (press the <A / B> key).
4. The channel balance can now be read out directly.

Signal-to-Noise Measurement

The signal-to-noise ratio (S/N), generally expressed in dB, reflects the ratio of the RMS Voltage of the wanted signal to the coexistent noise in a transmission channel.

1. Set the analyzer to measurement function *L.REL*, expressed in [dBr].
2. Connect the A2/A2-D output to the input of the DUT and apply the wanted signal.
3. Mute the output of the generator or DUT, in order to receive the noise signal only.
4. Press the <SET REF> key
5. De-mute the output of the generator / DUT. The displayed measurement result corresponds to the signal-to-noise ratio, expressed in dB.

> ***NOTE*** ***<u>Do not</u> use the Noise function to evaluate the signal-to-noise ratio, since this mode measures the quasi-peak weighted noise, instead of the RMS voltage as required for S/N measurements.***

THD+N Function

The A2/A2-D measures the Total Harmonic Distortion plus Noise (THD+N) of the active channel by inserting a band-reject (notch) filter into the signal path. This notch filter is tuned to the frequency of the main component of the input signal (i.e. the fundamental frequency). Thus, the fundamental frequency is removed, leaving everything else - i.e. the harmonic distortion and noise - for the measurement. The result of this measurement is compared to the level of the incoming signal and expressed in percent [%] or in dB.

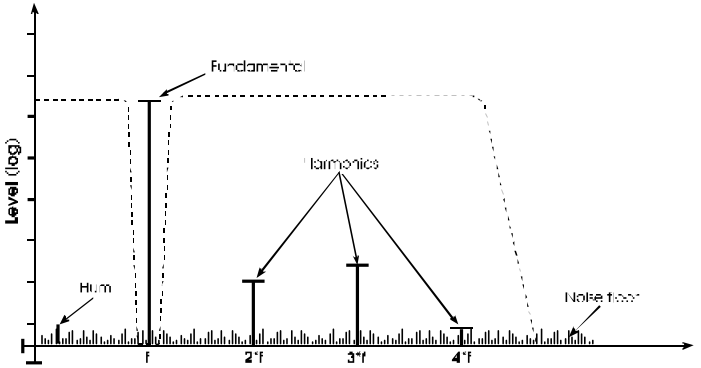
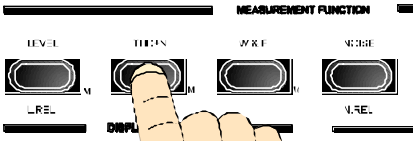


Fig. 19 Principle of THD+N Measurement



To enter the THD+N measurement function, press the <THD + N> key. This button toggles between the measurement function THD+N and IMD.

> ***NOTE Activation of the THD+N measurement function automatically selects the sine signal as output for the A2/A2-D generator.***

At the same time, the notch filter is inserted into the signal path, and the THD+N value is calculated according to ***Equation 1***.

$$THD+N = \frac{(Distortion+Noise)}{Signal+(Distortion+Noise)}$$

Equation 1 THD+N Calculation

> ***NOTE If the level of the input signal is too low, or not present at all, the message* INP LOW *will appear on the METER display.***

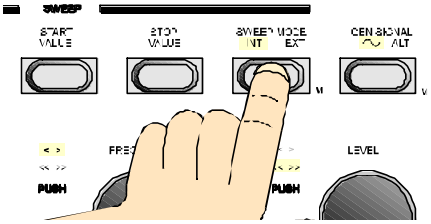
Notch Filter

To control of the center frequency of the notch filter, proceed in either of the two ways described below.

1. Lock the center frequency of the filter to the generator output frequency
2. Let the center frequency synchronize to the dominant frequency of the input signal.

Controlling the filter *internally* by the generator allows the filter settle in the quickest way. This helps to speed-up sweeps, but requires the internal generator as signal source. Furthermore, the DUT must not produce a frequency shift if using this mode.

Filter control *externally*, i.e. by the dominant frequency of the input signal may be useful and necessary if the DUT is stimulated by another signal source than the A2/A2-D generator (e.g. a test tape).



To set the control of the filter center frequency to either mode use the <INT EXT> button. Each press toggles between the two settings.

- INT means, that the notch filter is locked to the generator frequency
- EXT will synchronize the notch filter to the dominant input frequency.

Hint *The status of the <INT EXT> key only has an effect for measurement functions with variable filters, such as THD+N, L.SEL and X-TALK.*

Additional Filters

The A2/A2-D allows to additionally use the complete set of availabel filters for THD+N measurements. If no additional filter is activated, the bandwidth is limited to 250kHz.

Activating the Audio bandpass filter (22Hz-22kHz) primarily reduces the noise content of the signal.
But be careful - it will also reject all harmonics above 22kHz! For instance, with a stimulus of 6kHz and activated Audio bandpass filter, the THD+N result would make no sense, since already k_3 (the 3rd harmonic) and all upper harmonics will not be considered.

The 400Hz highpass filter mainly eliminates low-frequency disturbing signals like hum and its harmonics as well as rumble.
However, do not measure the THD+N of signals below 250Hz with the 400Hz high pass filter being enabled, since the second harmonic would not be measured in this mode.

NOTE ***To characterize the dominant type of distortion, enter the display mode SCOPE. The second trace in that display shows the residual distortion signal. Check for any correlation to a harmonic or hum etc.***

Units

The THD+N measurement as well as the SINAD measurement described below are relative measurements. The units available are therefore the linear percent [%] scale and the logarithmic decibel [dB] scale, that may be activated through the <UNIT> key.

SINAD Measurement

The A2/A2-D is also capable of measuring the SINAD value, although there is no special key provided for this function. This is because of the SINAD function being very closely related to the THD+N function.

The THD+N value quantifies the *distortion* of the signal, while the SINAD value expresses the *purity* of the signal.

$$THD+N = \frac{(Distortion+Noise)}{Signal+(Distortion+Noise)} \quad \text{and} \quad SINAD = \frac{Signal+(Distortion+Noise)}{(Distortion+Noise)}$$

From that follows

$$SINAD\,[\%] = \frac{1}{THD+N\,[\%]} \quad \text{and} \quad SINAD\,[dB] = -THD+N\,[dB]$$

Equation 2 SINAD Calculation

From these equations we can see, that the SINAD value is the reciprocal value of the THD+N.

- If expressed in a logarithmic unit (dB), the reciprocal value can be found by simply inverting the sign of the result.
- If expressed in a linear scale (%),the reciprocal value can be calculated by building the reciprocal. However, expressing the SINAD in % is not common.

NOTE The SINAD value, expressed in dB, is the negative of the THD+N value, expressed in dB.

Example

THD+N = -70dB ⇒ SINAD = 70dB

THD+N = 0.03% ⇒ SINAD = 3333

IMD Function

IMD (Intermodulation Distortion) is another form of distortion measurement. The device under test (DUT) is stimulated with a signal being composed of a low frequency and a high frequency tone.

If the DUT produces non-linear distortions, new frequencies will be added to the stimulating signal. These distortion products are measured and set into relation to the total output signal of the DUT, consisting of the stimulus plus the distortion products. The IMD value is a ratio expressed in dB or in %.

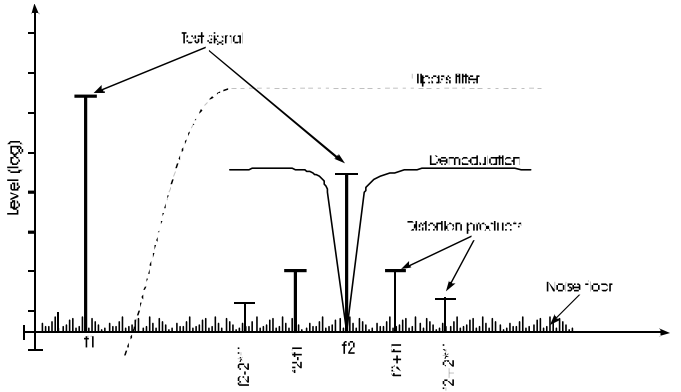


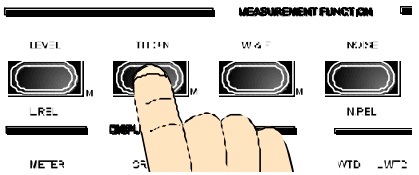
Fig. 20 IMD Measurement Principle

The advantage of the IMD measurement function, in comparison to THD+N, is that its dual-tone stimulus comes much closer to reality than a single tone test signal.
Furthermore, distortions can be measured up to higher frequencies, since the required bandwidth is only

$$Bandwidth = f_2 + n * f_1$$

where ***n*** is the *order* of the distortion product.

The high-frequency signal component *f2* can be set to any frequency above 4kHz. This allows also to perform IMD sweeps. The 4kHz limit avoids, that intermodulation products are filtered out by the highpass filter, i.e. that possible harmonics of the low-frequency tone would not to be measured.



To select the IMD function, press the <IMD> button, which is identical to the <THD+N> key, until the LCD shows *IMD*.

Each further press toggles between the THD+N and IMD measurement functions.

Activation of the IMD measurement function will automatically make the actual IMD test signal the output signal of the A2/A2-D. This is indicated by the illuminated *ALT* LED on top of the <GEN SIGNAL> button.

The type of the IMD test signal is displayed in the generator status line on top of the METER display (see chapter ***Standards*** below).

The frequency range of the higher frequency is limited from 4kHz to 40kHz. The displayed generator frequency represents the frequency of the higher tone, while the lower tone is fixed to either 60Hz or 250Hz. Should the selected generator frequency exceed this range, then it is automatically set to the min / max allowed IMD frequency.
The displayed readbck level equals the RMS level of the output signal.

The displayed IMD value is calculated according to

$$IMD = \frac{Sidebands}{Signal(f_2) + Sidebands}$$

The maximum IMD result is limited internally by the A2/A2-D to 10%, which equals -20dB. Higher values would overload the reference circuitry.

Since the Crest factor of the IMD signal is higher than the one of a pure sine signal, the maximum output level has to be limited too, in order to ensure that the output amplifier does not clip at the maximum peak amplitude. Obviously, the maximum IMD amplitude depends on the selected standard 1:1, 1:4 or 1:10 (see next chapter).

Standards

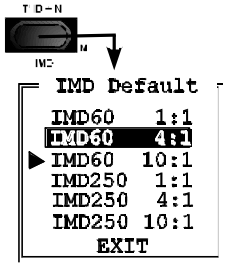
Both the frequency of the lower tone *f1* and the level ratio of the two tones are standardized. Since several standards exist, the A2/A2-D was designed to allow IMD measurements according to all these standards.
The list of the implemented standards is given below.

DIN 45403/4 Frequency f2 shall be either 4kHz or 5kHz. The amplitude ratio shall be preferably 4:1 but 10:1 is also allowed.

IEC 268/3 The frequency f2 shall be 8*f1. f1 shall be preferably 250Hz. Amplitude ratio is 4:1

SMPTE Low frequency shall be 60Hz. High frequency either 7kHz or 8kHz. Amplitude ratio 4 : 1.

Some standards fix the high frequency to 7kHz or 8kHz. However, it may be useful to vary the high frequency over the entire frequency range. Therefore, the A2/A2-D allows to set the high frequency freely in the range from 4kHz to 40kHz.



To select one of the available standards, enter the *IMD Default* menu, by double-pressing the <IMD> button.
The menu shows a list of the two low frequencies 60Hz and 250 Hz and the three amplitude ratios 1:1, 4:1 and 10:1.

Use the <SCALE> softwheel to move the arrow to the required selection, and push the wheel once to activate the selection. The menu closes automatically after the selection.

To leave the menu without altering the current signal, select EXIT or press any other key.

Unit

The IMD measurement result may be expressed either in dB or %, selected through the <UNIT> button.

Filters

As shown in ***Fig. 20***, the IMD measurement requires a special demodulation circuit and fixed filters. All these filters are set automatically when activating the measurement function IMD. Consequently, no other filters are allowed to be used for IMD measurement - thus, the whole filter bank is disabled.

Applications

Intermodulation distortion measurements are of advantage in comparison to THD+N measurements especially in the higher frequency range, where a THD+N measurement requires a fairly large bandwidth. Furthermore, the stimulation of a DUT with two in parallel comes closer to the reality than a single sine stimulus.

IMD test are often used to characterize the non-linear distortions of amplifiers, mixers, compressors, etc.

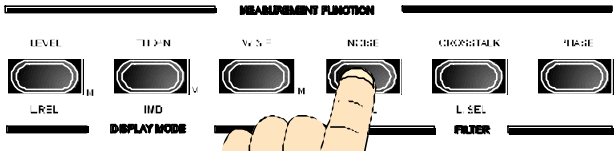
Noise Function

The Noise function of the A2 measures noise according to the CCIR Recommendation 468/3 and 468/4, in either absolute or relative terms. The signal path in the Noise function includes either the Audio bandpass filter or the weighting filter defined in the above standard. The internal rectifier of the A2/A2-D always measures Quasi-peak in function Noise.

The Quasi-peak rectifier is a RC-network that has a very short attack time but quite a long decay time. This type of rectifier especially weights the spikes in the noise signal, so that the result corresponds closely to the audibility of the signal.

Nevertheless, some applications (e.g. signal-to-noise ratio require to measure noise RMS rectified, maybe even with a specific weighting filter. The A2/A2-D can also perform these measurements in the LEVEL function with the corresponding filter (e.g. A-weighting).

To perform a Noise measurement, apply the signal to be measured to the active input connector and press the <NOISE> key.



Each further press to the <NOISE> button will toggle between the absolute and relative Noise measurement function, denoted by NOISE and N.REL in the display. Select NOISE for absolute measurements.

The METER display shows the result together with the weighting mode on top, along with the generator / input level and frequency.
If a signal consisting of random noise is applied to the A2/A2-D, the frequency reading will not be stable, since no periodic signal is found.

Units

The available units in function Noise are dBq and Vq, where the "q" stands for Quasi-peak rectified. The reference voltage (0dBq) for the Quasi-peak rectifier is 0.775V.

Filters

Noise measurements can be done either weighted or unweighted, whereof in both modes a specific weighting filter is active. This is necessary according to the standards, since unlimited bandwidth would lead to an unlimited high noise signal.

- Press the <WTD UWTD> key to enter the weighted mode, where the CCIR-468/3 filter is active (LED *WTD* lights up).
- If the unweighted mode is selected, the 22Hz-22kHz Audio Bandpass is activated automatically (LEDs *UWTD* and *22-22k* are lit).

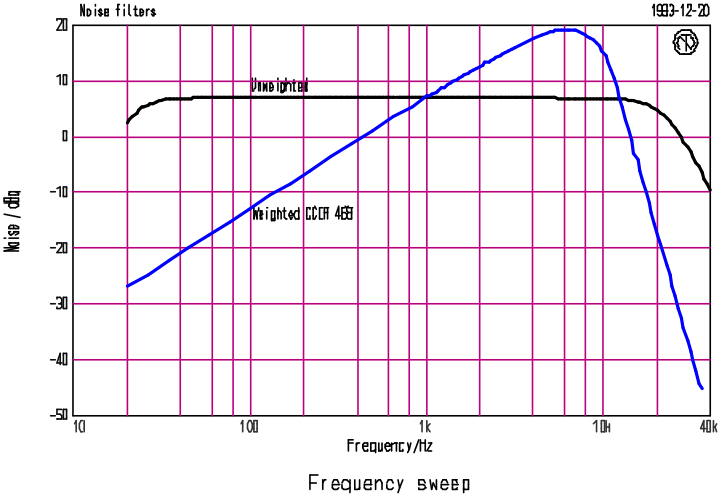


Fig. 21 Noise Weighting Characteristics

Applications

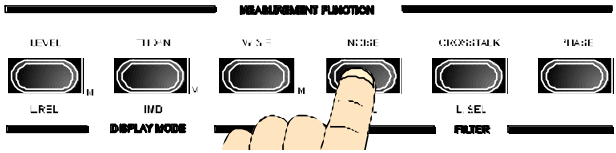
Noise measurements are helpful if the noise content of the signal is dominant, e.g. to measure the minimum output level of an amplifier. Please notice, that it is essential to terminate the inputs of the DUT properly, in order to avoid the introduction of external noise.

> ***NOTE*** ***<u>Do not</u> use the Noise function to evaluate the Signal-to-Noise ratio. The reason is, that the Noise mode of the A2/A2-D measures according to the CCIR standard (peak-weighted), while for the S/N ratio, a RMS-weighted measurement has to be executed (see p. 48).***

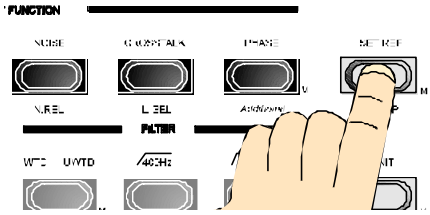
Noise Relative Function

In opposition to the absolute Noise function, that measures against the fixed reference of 0dBq = 0.775V, the *Noise Relative* mode allows to make any input signal the reference level.

To perform a Noise Relative measurement, push the <NOISE> button until *N.REL* appears on the LCD.



Every push to the <NOISE> button toggles between the two functions NOISE and N.REL.



To define the reference noise level, apply the desired signal to the main input channel and press the <SET REF> button. This reference value is shown in the bottom display in the generator unit.
Now apply the signal to be measured to the analyzer. The displayed result reflects the ratio of the input noise level to the stored reference.

Keep in mind, that the reference value remains active even after switching Off the system. Furthermore, please notice that the reference noise level does not equal the reference levels of other relative measurement functions (e.g. Level Relative).

Units

The Noise Relative function offers several units, which can be chosen through the <UNIT> button.

Unit	*lin/log*	*Calculation*
*1	lin	$\frac{U_{IN}}{U_{REF}}$
%	lin	$\frac{U_{IN}}{U_{REF}} \cdot 100$
dBr	log	$20 \cdot \log(\frac{U_{IN}}{U_{REF}})$

Filters

Like Noise measurements, Noise Relative can be measured as well either weighted or unweighted (see ***p. 55***).

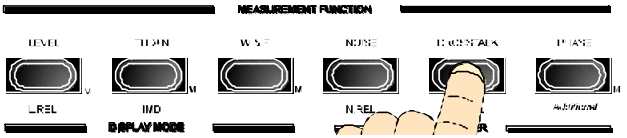
- Press the <WTD UWTD> key to enter the weighted mode, where the CCIR-468/3 filter is active (LED *WTD* lights up).
- If the unweighted mode is selected, the 22Hz-22kHz Audio Bandpass is activated automatically (LEDs *UWTD* and *22-22k* are lit).

NOTE ***In the Noise Relative measurement function, the weighting by a CCIR 468 filter applies to both the input and reference signal. Therefore, the gain with and without the filter is equal at 1kHz only.***

Crosstalk Function

The Crosstalk function - also called Stereo Separation - measures the interaction from one channel to the other. The measurement is done by sending a sine signal through the one channel, while the selective output level of the other channel (the one that is not stimulated), is measured at a certain frequency. The resulting level ratio between the muted channel and the active channel is the Crosstalk value.
Like with the Level Relative function, the Crosstalk measurement is performed by inserting a narrow bandpass filter into the analyzer path.

To measure the Crosstalk, connect the generator outputs of the A2/A2-D with the inputs of the device under test (DUT), and the two output lines of the DUT with the input channels A and B of the A2/A2-D.
Then press the <CROSSTALK> button once, so that the display will show *XTALK*. Each further push toggles the function between *XTALK* and *L.SEL*.



The *generator output* of the *active analyzer channel* is automatically muted, in order to simplify the Crosstalk measurement. Furthermore, the selective bandpass filter is inserted automatically into the analyzer path of the active channel, and tuned to the oscillator frequency. The frequency range of the filter is from 10Hz to 50kHz.

> ***NOTE*** ***The Crosstalk value depends very much of the frequency. Since most Crosstalk is caused by capacitive or inductive coupling, an average increase of 6dB per octave and coupling element will result.***

Units

Since the Crosstalk result is a ratio of two levels (relative value), it can be expressed in units with no dimension only. Following units may be chosen through the <UNIT> button.

Unit	*lin/log*	*Calculation*
*1	lin	$\frac{U_{Active(filtered)}}{U_{Inactive}}$
%	lin	$\frac{U_{Active(filtered)}}{U_{Inactive}} \cdot 100$
dBr	log	$20 \cdot \log(\frac{U_{Active(filtered)}}{U_{Inactive}})$

Filters

The Crosstalk measurement automatically inserts the narrow bandpass filter (see ***Fig. 22***) into the active analyzer path.

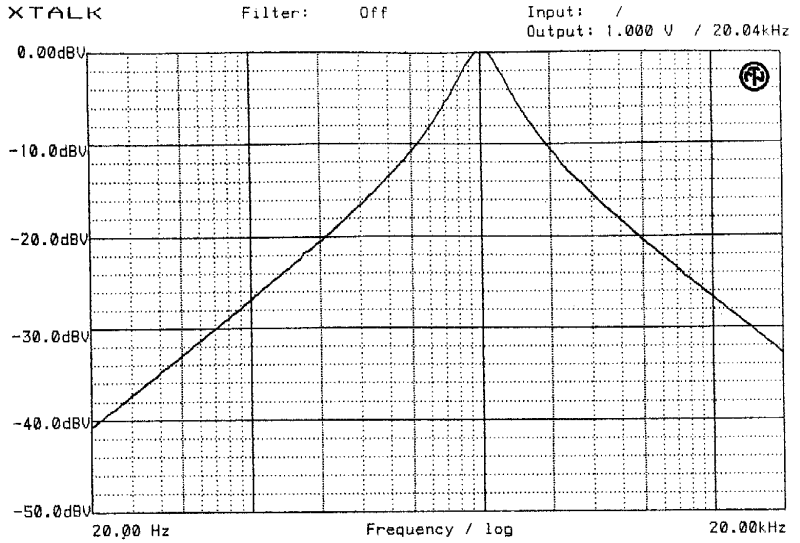
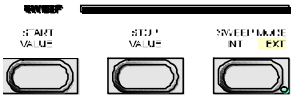


Fig. 22 Narrow Bandpass Filter Characteristics

Furthermore, in order to limit the measured bandwidth and / or to reject hum components in the measurement signal the standard filters (400Hz HP and audio BP) may be activated.

External Source

The A2/A2-D is also capable to measure the Crosstalk from any external source like a CD-player or a test tape instead from its own generator. The only difference to the previously described method is, that the tracking/receive filter has to be controlled and tuned to the input frequency instead of the internal oscillator.



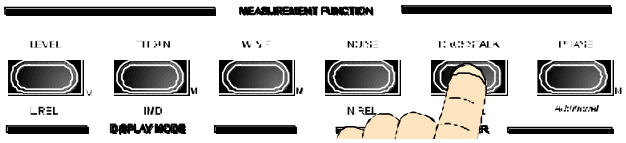
This can be done by pushing the <INT EXT> button once, so that the LED behind the *EXT* sign lights up. The rest of the procedure is exactly the same. The track or tape with the test signal has to be fed to the inactive input channel while the quiet channel is fed to the active one.

NOTE It is advisable to measure Crosstalk not only from chn. A to B, but also from chn. B to A. There might be noticeable differences in the results.

Level Selective Function

The Level Selective measurement function measures the RMS level of the input signal but, by applying a narrow bandpass filter to analyze a small frequency band only.

To enter the Level Selective measurement function, press the <L.SEL> button one or two times, so that the LCD shows *L. SEL*. Each further press to the button toggles the measurement mode of the A2/A2-D between *XTALK* and *L.SEL*.



Filters

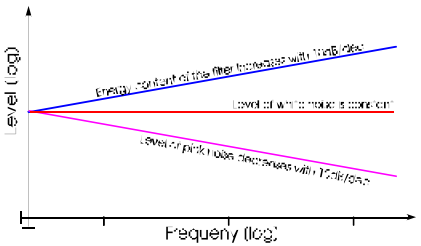
In *L. SEL* mode, the displayed result equals the RMS energy content of the signal, measured behind a narrow bandpass filter. This filter is of 2nd order with Q = 5 and a constant *relative* bandwidth. This means, that the filter characteristic has the same shape if plotted vs. a logarithmic scale, regardless of the actual frequency to which it is set.

The characteristic of the narrow BP filter is the same as plotted in chapter ***Crosstalk Function***, p. ***59***.

This filter type has the advantage of being tunable over the whole Audio range up to 50kHz, and of having a constant Q factor over the entire frequency range.

With its constant relative bandwidth, the energy content of *white noise* under the filter is not constant but increases with 10dB/decade.
For instance, the thermal noise of electronic devices typically shows a linear distribution, i.e. very similar to white noise. Therefore, if analyzed with the Level Selective measurement function, the result will rise proportional to the frequency.

> ***NOTE*** ***When analyzing white noise with the level selective function of the A2/A2-D, the analyzed amplitude will increase by 10dB/decade if plotted against the logarithmic frequency axis.***



On the other hand, pink noise exactly compensates this effect with its *constant* amplitude vs. the *logarithmic* frequency axis (decrease of 10dB / decade vs. the linear frequency axis).

Consequently, if *pink noise* is analyzed with the Level Selective function, the measured result will show a constant level vs. the logaritmic frequency axis.

In practice, this effect may be used to evaluate the frequency response of a device under test (DUT) while being stimulated with a broadband stimulus.

To do this, simply set the generator of the A2/A2-D to Pink Noise and record a sweep with the Level Selective function - the resulting curve will reflect the frequency response of the DUT.

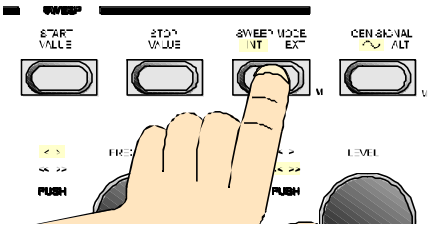
External Source

To control of the center frequency of the bandpass filter, proceed in either of the two ways described below.

1. Lock the center frequency of the filter to the generator output frequency
2. Let the center frequency synchronize to the dominant frequency of the input signal.

The locking to the generator frequency has the main advantage of a faster settling. It is therefore recommended for all measurements where the generator acts as the signal source, and where the DUT shows no frequency shifts.

The second method, i.e. synchronizing the bandpass filter to the input frequency, is best fitted for all measurements where the stimulus of the DUT comes from an external generator (e.g. measurements from a tape or a remote A2/A2-D).



To set the control of the center frequency to either mode use the <INT EXT> button. Each press toggles between the two settings.

- INT means, that the frequency is locked to the generator frequency.
- EXT will lock the center frequency of the bandpass filter to the dominant input frequency.

Hint *The status of the <INT EXT> key only has an effect for measurement functions with variable filters, such as THD+N, L.SEL and X-TALK.*

Units

Since Level Selective is an absolute measurement, the available units are the same as for the measurement function Level (V, dBV, dBu / dBm).

Applications

- Spectral analysis of stationary signals.
- Accurate level measurements below the wide-band noise floor.
- Accurate frequency analysis in a noisy environment.

Wow & Flutter Function

Wow and Flutter (W&F) describes the frequency modulation, that is introduced by an irregular motion of the recording medium (e.g. a tape), during the recording or reproduction process.

- *Wow* describes the modulations within the frequency range of 0.5Hz - 6Hz, which is perceived as a fluctuation of the pitch.
- *Flutter* covers frequency modulation in the range of approx. 6Hz - 100Hz results in an increase of the roughness of the sound.

The W&F function measures the Wow and Flutter of tape recorders and turntables, either weighted or unweighted, according to various international standards, from either a 3.15kHz or 3kHz signal. Though several standards exist, they fall into two groups; within these groups, the standards are functionally identical.

One group consists of IEC 386, DIN 45 507, BS 4847 and CCIR-409. They measure with quasi-peak rectifier.

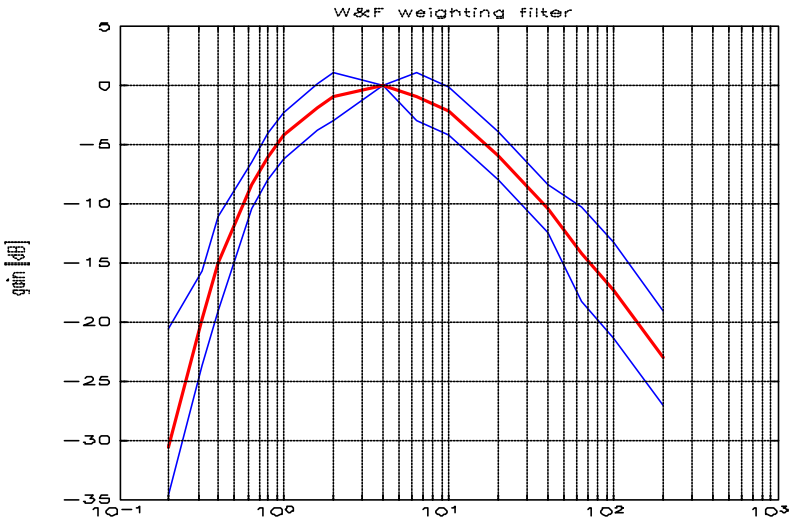
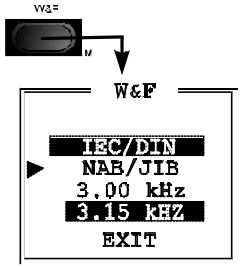


Fig. 23 W&F Weighting Filter Standards

The other group, comprising of NAB and JIS C 5551, measures with a VU-like response. Both groups use the same weighting curve.

The IEC group normally measures from 3.15kHz, and the NAB group from 3kHz. However, in the A2/A2-D measurements may be made according to either standard and frequency; there is no need to buy two different test tapes.

Standards



All standards described before can be selected out of the *W&F* menu, that may be opened by a double-click ot key <W & F>.

Move the arrow to the standard of your choice by turning the <SCALE> wheel, and confirm by pushing the wheel. Alternatively, leave the menu through the EXIT entry or by pressing any key.

Any time you enter the W&F functi on now, the last selected standard is applied. Furthermore, it is displayed right of the *W&F* sign on the METER display.

The generator is automatically set to the selected frequency in the W&F mode. When switching to another measurement function (e.g. Level), the generator frequency is set back to the previous value. This "intelligence" allows e.g., to execute very quickly a Level measurement at 1kHz, switch over to W&F at 3.15kHz and then measure THD+N at 1kHz without the need to access the generator frequency.

W&F Measurements (Replay only)

For this measurement method you need a standard W&F test tape.

1. Connect the replay output of the recorder under test to the active input of the A2/A2-D. Load the standard wow and flutter test tape. Make sure, that the settings of the frequency corresponds to the test tape.
2. Press the <W&F> and <METER> buttons. One of the LEDs over the <WTD UWTD> button will be lit, indicating either the weighted (W&F filter active) or unweighted (audio bandpass filter active) mode. Select the appropriate filter through the <WTD UWTD> key.
3. Start the tape in the replay mode. The LCD will show one measurement of Wow & Flutter in big digits, and one of Drift on the bottom line, both as a percentage. The wow & flutter result will also be shown on the bar-graph.
4. If the input level from the recorder is too low, the message *INP LOW* will appear.

NOTE ***The A2 does not strictly measure drift, but rather speed error. Drift is the difference in speed between the beginning and end of a tape or disc. Therefore, to measure drift, you will need to take two measurements, one near the beginning and one near the end, and subtract one from the other. Be careful if one has a positive and the other a negative result!***

W & F Measurements (Record to Replay)

The procedure is basically the same as before, except that the blank tape has to be recorded first. To do this, proceed as follows.

1. Connect the generator output of the A2/A2-D to the record input of the recorder.
2. Load a blank tape.
3. Start the tape machine in the record mode.
4. After a suitable length of recording (usually at least 30 seconds), rewind the tape and restart in the replay mode.

> ***NOTE*** ***Don't measure wow and flutter whilst actually performing the recording, because W&F at some frequencies will be canceled out, and the measurement will be lower than the truth. Frequencies which will be canceled, are those where the delay from the record head to replay head is an exact multiple of the time period (duration of one cycle) of the wow frequency. The effect is that of a comb filter.***

For the same reason, to get a more reliable result, rewind and repeat the measurements several times, and average the results. Only one recording is necessary.

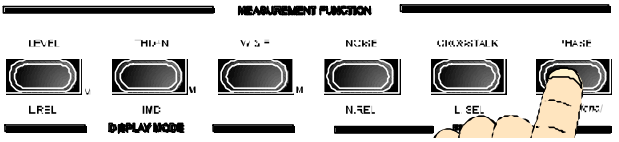
W&F Signal Analysis

By pressing the <SCOPE> button, the waveform of the demodulated wow & flutter signal will be displayed on the screen. Regular periodic wow & flutter can be identified from this waveform. From the frequency, the offending rotating components can be deduced (capstan, pinch wheel, idlers, intermediate wheels, etc.)

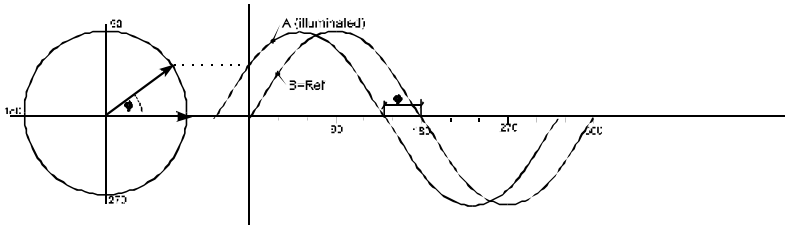
Phase Function

This function evaluates the interchannel phase in degrees, i.e. it measures the phase shift of the active channel against the inactive channel (reference channel). The phase correlation of the two channels is displayed in the full range of ±180° degrees.

To enter the Phase measurement function, press the <PHASE> button. The LCD will show *PHASE* and the measurement result.



A positive measurement result, e.g. +30°, with channel A being active, means that the signal of channel A passed the zero volts line 30° before the signal of channel B did.



The <UNIT> button has no effect in the PHASE function, due to the fact that degrees is the only available unit.

> ***NOTE The max. allowed level difference between the input channels is 18dB.***

Applications

- Phase response of the device under test (output to input).
- Phase relation of the two output channels.
- Tape head azimuth adjustments.

Filter Overview

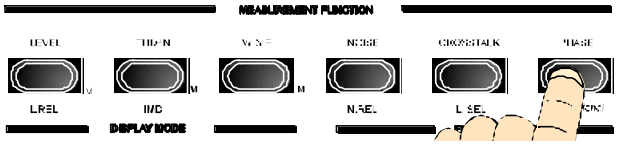
The table below list all standard and optional filters of the A2/A2-D, and indicates their availability for the different measurement functions (✓ = available; **!** = compulsory).

Meas. Function	/400Hz LP	/22-22k\ Audio BP	Notch	IMD	W&F	CCIR-486	AO4 A-weight.	AO5 User	AO13 C-mess.	AO14 80kHz LP
LEVEL	✓	✓	-	-	-	-	✓[3]	✓[3]	✓[3]	✓[3]
L.REL	✓	✓	-	-	-	-	✓[3]	✓[3]	✓[3]	✓[3]
THD+N	✓	✓	!	-	-	-	✓[3]	✓[3]	✓[3]	✓[3]
IMD	-	-	-	!	-	-	-	-	-	-
W&F	-	-	-	-	✓	-	-	-	-	-
NOISE	-	![4]	-	-	-	![4]	-	-	-	-
N.REL	-	![4]	-	-	-	![4]	-	-	-	-
XTALK	✓	✓	-	-	-	-	-	-	-	-
L.SEL	✓	✓	-	-	-	-	✓	✓	✓	✓
PHASE	-	-	-	-	-	-	-	-	-	-

Table 4 Filter Availability

ADDITIONAL Function

If equipped with the Digital Option (order code: AO10), the A2/A2-D can offer even more measurement functions, which may be very helpful for some applications.
In this case, the corresponding measurement mode may be entered through the <*ADDITIONAL*> key (the second function of the <PHASE> key). Each press to this button toggles between the functions <PHASE> and <*ADDITIONAL*>. If no digital option is installed, the A2/A2-D will remain in the Phase measurement function.



Please refer to the ***AO10 User Manual*** for further information.

[3] One filter option may be activated at a time only, while both the 400Hz LP and 22Hz-22kHz BP will be de-activated

[4] Either the 22Hz-22kHz (UWTD) or CCIR486 (WTD) filter is active in measurement function NOISE / N.REL

6. SWEEPS

The A2/A2-D is not only capable to measure single values but also has a built-in set of powerful sweep capabilities, that enable the user to record complete graphs in a few steps.

Following sweep modes are supported, allowing to record almost all available measurement functions of the A2/A2-D against various parameters.

- Frequency sweeps, internally controlled by the generator
- Frequency sweeps, controlled by an external source
- Frequency sweeps, controlled by the generator with av fixed interval per step (tape sweeps)
- Amplitude sweeps, controlled by the generator
- Time sweeps
- Table sweeps, where discrete sets of frequency / level pairs are stored in the internal memory of the A2/A2-D (requires RS232 or IEEE interface option)

All these sweep types can be performed at either LOW or HIGH resolution (number of samples between the start / stop values). Pleas notice, that not all measurement functions can be swept in all available modes (e.g. W&F cannot be swept at all).

NOTE Several sweeps can be recorded, re-scaled and printed in the same graph and up to four complete graphs can be stored in the internal memory of the A2/A2-D for later use and printout.

Preparing a Sweep

Sweeps are normally visualized in the GRAPH display mode, that can be entered any time by pressing the <GRAPH> button. Keep in mind, that even during the preparation or execution of a sweep, all three display modes (METER, GRAPH and SCOPE) may be entered.

To prepare a sweep, first define the sweep limits, i.e. the start / stop values. Although the A2/A2-D offers default settings, they can be adapted individually to the actual demands. Next, the resolution, i.e. the number of measurement points between these limits, has to be set. Last but not least, select the measurement function to be recorded.

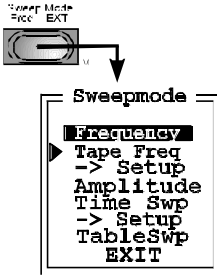
After starting the sweep, the A2/A2-D takes over control of the entire process, including ranging and display scaling. It automatically chooses internal settling parameters, to make the sweep as fast, but as accurate as possible too. Almosr simultaneously, the recorded curve becomes visible in the GRAPH display.

If necessary, the recorded curve can be kept in the internal memory of the A2/A2-D, together with the following one etc. In this way, up to six traces may be stored in one graph.

Of course, the complete analysis of a DUT may consist of several graphs, acquired with different measurement functions. Therefore, four complete graphs can be stored in the internal memory of the A2/A2-D. Please refer to the following chapters for further details.

Selecting the Sweep Mode

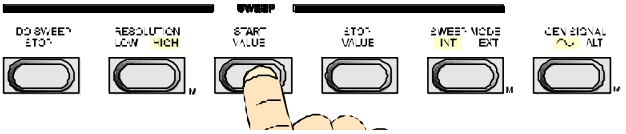
The A2/A2-D is able to perform several sweep types. They can be chosen from the menu behind the <SWEEP MODE> button (refer to chapter ***Sweep Modes*** for further details).



Activate the *Sweepmode* menu by a double-click to the <SWEEP MODE> button. The arrow in the menu can be moved to the required entry with the <SCALE> wheel. Confirm your selection by pushing the wheel once.
Some entries, like *Tape Freq* and *Time Swp* have a further menu behind, that allows to define some more parameters of the specific sweep type. The detailed explanations of these parameters are given in the description of the corresponding sweep type.
The menu closes automatically after the confirmation. Selection of the entry EXIT or any keypress will close the menu without any change.

Setting the Sweep Limits & Resolution

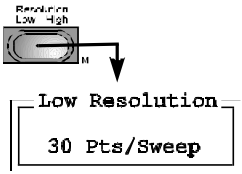
In the sweep modes *Frequency* and *Amplitude* , the limits of the sweep can be chosen freely in the range of the internal generator.



This is done by setting the generator to the required start value (in *Frequency* mode: the start frequency - in *Amplitude* mode: the start level) and pressing the <START VALUE> button. Consequently, the A2/A2-D accepts the current generator frequency / level value as start value and re-scales the X-axis of the graph.
To define the stop value, proceed the same way, but press the <STOP VALUE> button. Consequently, the X-axis will show the user-defined sweep range.

> ***NOTE*** ***The start value doesn't need to be lower than the stop value - it is also possible to sweep from a higher to a lower frequency / level by setting the start & stop values accordingly. Nevertheless, the x-axis will always drawn in increasing order from left to right, even if the sweep is performed in the other direction.***

The resolution of the sweep can be set to two stati, either LOW or HIGH. High resolution sweeps are performed if the accuracy is important, while the low resolution is chosen if speed is the major issue.



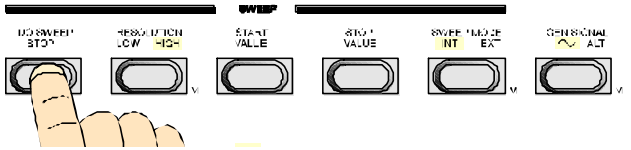
The number of points can be altered by the user for both settings by double-clicking the <RESOLUTION> key in the corresponding status.
This will open the *Resolution* menu, showing the actual number of points. Turn the <SCALE> wheel to increase or decrease the number and push the wheel to confirm the selection.

The table below lists the possible ranges of the LOW / HIGH resolution.

RES	Min	Max
LOW	2	50
HIGH	30	200

Performing a Sweep

As soon as the sweep parameter definition has been finished, the only step remaining is to start the sweep by pressing the <DO SWEEP>> / <STOP> button.



This button starts a new or stops a running sweep. Keep in mind, that a running sweep will be processed and scaled automatically.

> ***NOTE If the sweep doesn't start after the DO SWEEP command, then the sweep mode is most probably set to external.***

Synchronization (Internal / External)

Normally, the variable sweep parameter (e.g. frequency) is controlled *internally* by the generator of the A2/A2-D, so that the analyzer may be synchronized automatically to this parameter.

Nevertheless, there are also applications, where the variable sweep parameter is generated *externally*, so that the analyzer of the A2/A2-D must synchronize itself to this parameter. Unfortunately, this cannot be done for all of the three available sweep parameters. For instance, synchronization to the externally generated, swept amplitude of an amplitude sweep is not possible.

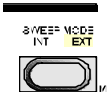
In practice, the synchronization of the A2/A2-D analyzer is necessary for THD+N, Level Selective and Crosstalk measurements. Each of these functions comprises a specific tracking filter, i.e. a notch or bandpass filter with variable center frequency, that must be synchronized to the generated frequency.

Table 5 provides an overview over the available synchronization modes for internally and externally controlled sweeps.

Sweep Type	***Internal Control***	***External Control***
Frequency Sweep	Yes	Yes
Tape Frequency Sweep	Yes	Yes
Amplitude Sweep	Yes	No
Time Sweep	Yes	Yes
Table Sweep	Yes	No

Table 5 Sweep Synchronization Modes

To set the sweep mode to *external* synchronisation, set the <SWEEP MODE> button to *EXT*. In this mode, the tracking filter and the sweep measurements are controlled by the frequency counter of the active A2/A2-D analyzer channel.



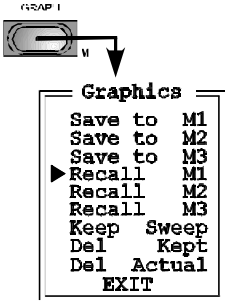
In position *INT*, the control of the sweep and the tracking filter is done by the internal oscillator of the A2/A2-D.
This mode is much faster than external sweeps, since both the tracking filter and analyzer get the frequency information directly from the generator.

Please refer also to chapters ***Frequency Sweep*** and ***Tape Sweep*** for further information.

Sweep Recording

Keep a Recorded Trace

To keep a recorded trace on the screen, open the *Graphics* menu by double-clicking to the <GRAPH> button in the GRAPH display mode. Move the arrow to the entry *Keep Sweep* and confirm by using the <SCALE> softwheel.



Consequently, the last recorded trace will be stored permanently. Any new sweep curve will be added to the same graph as long as actual the measurement function is not altered.

- To clear the current graph, use the command *Del Kept*. This command deletes all kept traces, but leaves the actual trace untouched.
- If you wish to delete the last (not yet kept) trace, use command *Del Actual*.

Keep in mind, that a recorded trace can be printed out only, if it has been kept before.

Store & Recall Sweeps

The A2/A2-D also offes the possibility to store the actual graph to one of three available memory locations. The stored information comprises the measurement function, the sweep mode, the actual set of kept traces, the scaling and the time & date of the internal real-time-clock. The memory is battery backed-up, so that the instrument may be disconnected from mains power and moved to another locations to get the print-outs etc.

To store a graph, select the menu behind the <GRAPH> button, and select one of the three *Save to Mx* entries by using the <SCALE> wheel. A push on the wheel confirms the selection and stores the Graph.

Depending on the resolution and the measurement function, up to 6 traces can be recorded per graph. The minimum capacities are

Function	***Resolution***	
	LOW	**HIGH**
1-CH	6	2
2-CH	3	1

Table 6 Minimum No. of Recordable Sweep Curves

To recall a stored graph, open the *Graphics* menu and select one of the *Recall Mx* menu entries. This process also re-activates the instrument set-up, that was active when the graph was saved. Recalling a graph does not clear the corresponding memory.
When moving the arrow along the *Recall Mx* entries, the bottom line of the LC display shows the stored time & date of the graph stored therein. If no graph has been stored in the corresponding memory location, *NO DATA* is shown instead. This feature simplifies the identifaction of stored graphs.

NOTE When recalling a graph, the actual graph on the display will be overwritten.

As soon as a graph has beeen recalled, additional traces may be recorded and added. The only limitations are given by the number of recordable traces and the measurement function, that must not be changed.
In other terms, if the measurement function is changed after having recorded one or more sweeps, all displayed curves will be deleted. Nevertheless, previously stored graphs are not affected by this.

Sweep Modes

Frequency Sweep

The most common sweep type is the internal frequency sweep, where the frequency is the variable sweep parameter, generated by the A2/A2-D. This sweep type is best suitable for DUTs that don't show a too long (< 2s) time delay between their in- and outputs. Obviously, the in- and outputs must not be loceted too far apart, so that they can be wired-up through cables to the A2/A2-D.

To perform an internal frequency sweep, proceed as follows.

1. Select the measurement function for the sweep (all functions available except W&F).
2. Enter the display mode to *GRAPH* by pressing the <GRAPH> button.
3. Activate the frequency sweep mode by double-clicking to the <SWEEP MODE> button and selecting the entry *Frequency*. Consequently, the bottom line of the display will show the actual sweep mode: *Frequency LOG*.
4. Use the <LEVEL> wheel to adjust the required generator output level. This setting will be displayed on top of the screen. The level of the generator will not vary during the sweep.
5. Set the limits for the frequency sweep by using the <START VALUE> and the <STOP VALUE> keys. Next, choose the resolution that meets your demands.
6. Press <DO SWEEP> to start the sweep. The status line at the bottom of the display will show *Freq RUNNING* while the sweep is performed and switch over to *Freq complete* as soon as the sweep is finished. You may abort a running sweep at any time by pressing <DO SWEEP / STOP> again. The next push of the <DO SWEEP> button will re-start another sweep recording and replace the previous trace.

> ***NOTE*** ***Each new sweep replaces the old one as long as the actual trace has not been kept (see chapter Keep a Recorded Trace).***

Y-Axis Units and Scaling

The <UNIT> button allows to set the unit of the Y-axis (measurement function). Please notice, hat the graph with all recorded traces will be re-calculated and re-drawn upon a change of the unit.

To change the scaling of the Y-axis, use the <SCALE> wheel as described in chapter ***GRAPH Display Mode*** (p. ***38***).

Re-Scaling of the Frequency Axis

If a sweep has already been recorded, but the displayed frequency range is too large, it can be adjusted easily by re-setting the Start- and Stop-frequency.
Set the generator frequency to the desired value of the lower / upper border of the frequency range. Next, press the <START VALUE> / <STOP VALUE> button respectively. Consequently, the recorded graph will be re-drawn in the new range.

> ***NOTE*** ***The recorded graph is not measured again, but re-drawn in the new range only. The parts of the curve(s) outside the displayed graph are not lost, but just not visible. It is therefore always possible to return to the original frequency range.***

Frequency Sweeps in Different Measurement Modes

The A2/A2-D2 can perform frequency sweeps in the measurement functions Level, Level Relative, Level Selective, THD+N, IMD, Noise, Noise Relative, Crosstalk and Phase, but not Wow & Flutter.

> ***NOTE*** ***It is useless to perform a LEVEL, L.REL, NOISE or N.REL sweep without stimulating the DUT with a signal. Since all these measurement functions rectify the wideband signal, the absence of a stimulus would result in no A2/A2-D input signal variation at all, i.e. the measured result would be stable for all frequencies, regardless of the charactristics (e.g. frequency response) of the DUT.***

Graphics Cursor

When turning the <FREQUENCY> softwheel after having recorded a sweep curve, a crosshair becomes visible in the graph at the generator frequency, while the bottom line of the LCD will show the interpolated measurement value.

The cursor disappears as soon as the upper or lower end of the frequency axis is reached and it is brought back as soon as the generator frequency is in the displayed range again.
In case of a 2-channel measurement, the cursor is assigned to the curve of the main channel, which is drawn in black. If you wish to measure the curve of the alternate channel, simply press the <A / B> key to toggle the active channel. The graph is re-drawn with inverted line style and the cursor is available on the other trace.

Keep in mind, that the cursor is not printed out with the curve.

Tape Sweep

Tape sweeps are very similar to "normal" frequency sweeps, except that the frequency steps last for a predefined duration. In other terms, with a normal frequency sweep, the generator will change its output frequency as soon as the analyzer has successfully executed a valid measurement, while with a tape sweep, the generator will let each frequency present for a fixed time, regardless of the status of the analyzer.
To fully understand this approach, pleas read the subsequent explanation.

The A2/A2-D has a built-in algorithm to ensure taht only stable signals are measured. In practice, several consecutive samples are recorded and tested for stability. If these samples are not stable enough, more samples are recorded until the stability criteria is met.
The required duration to get a stable measurement result strongly depends on the selected measurement function and the stability of the incoming signal. Normally, the required time for the data settling is rather short (typically ~200-500ms). However, this duration cannot be predicted exactly and is never constant.

Therefore, in order to allow the recording of a sweep even under worst-case conditions (THD+N measurement at very low frequencies) a special sweep mode has been introduced in the A2/A2-D. This mode is called *Tape Sweep*.

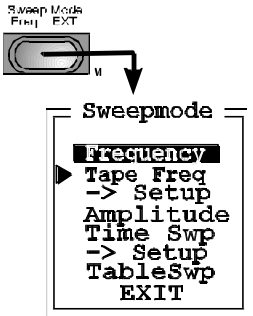
Actually, a tape sweep consists of a stepwise rising generator frequency, with fixed time intervals between the steps. The user-defined sweep parameters as well as the analysis and post rocessing capabilities are identical with the normal frequency sweep mode.

Recording a Tape Sweep

To record a tape sweep onto a tape, simply connect the outputs of the A2/A2-D to the inputs of your tape recording machine. Next, execute the following steps.

1. Enter the GRAPH display mode and set the start- & stop-frequency as well as the resolution. The required time for the whole sweep is determined by the number of steps multiplied by the time interval.

> ***NOTE*** ***In some measurement functions, the allowed frequency band is limited due to physical reasons. For instance, IMD measurements are not allowed to be measured below 4kHz. In these cases, the generator will not exceed the allowed range.***



2. Open the *Sweepmode* menu by double-clicking to the <SWEEP MODE> button. Select the -> *Setup* line push <SCALE> wheel once.

   A sub-menu will open to allow the definition of the step interval in the range of 0.5s, 1s, 2s, ..., 10s. The fastest possible setting strongly depends on the selected measurement function as well as the quality and stability of the recording. Push the <SCALE> wheel to confirm your selection.

   The bottom line of the LCD shows the mode *Tape* and the selected speed, as e.g. *3.0s /Step*.

3. Set the generator to 1kHz and to the desired output level. The 1kHz tone is required to identify the header of the sweep, i.e. to allow the sweep to start automatically.
4. Set the tape machine into the recording mode. The 1kHz output tone of the A2/A2-D shall be recorded for at least 3 seconds.
5. Press the <DO SWEEP> button to start the tape frequency sweep. By this, the message *Tape RUNNING* will be displayed on the bottom line of the LCD.
6. As soon as the sweep is completed, *Tape COMPLETED* will appear on the bottom line, indicating that the tape recorder may be stopped, followed by the message *Tape x.x Sec/Step*.

> ***NOTE*** ***When using a 2-head tape machine, the output of the replay-head may be connected to the analyzer of the A2/A2-D, in order to directly measure the response of the DUT.***
>
> ***However, keep in mind that certain tape machines (those with one head only) provide an "output" signal, that monitors to the preamplifier output, but not the recorded signal.***

7. Rewind the tape to the starting point and use the recorded track as the source for an external frequency sweep.

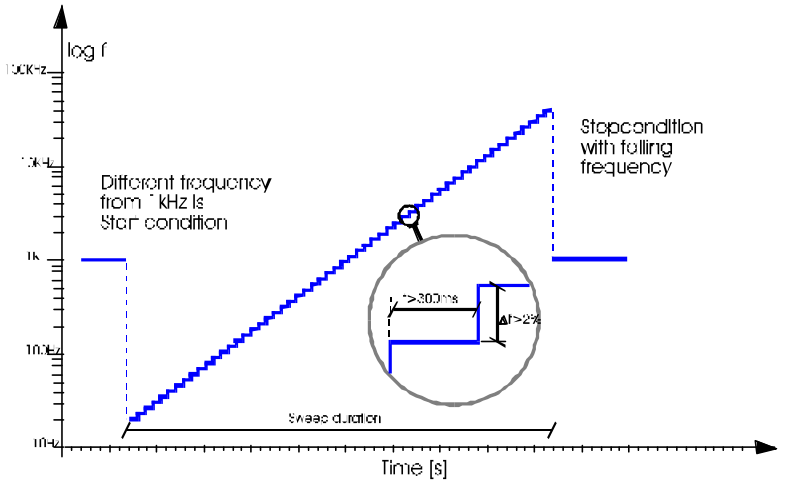


Fig. 24 Tape Sweep

External Sweep

The A2/A2-D is capable of performing external sweeps, i.e. to synchronize itself to the output signal of an external device such as a tape recorder or a CD-player. Obviously, the characteristics of such an external signal must correspond to the *Tape Sweep* described in the previous chapter.

In the external sweep mode, the analyzer will synchronize its tracking filter to the incoming signal. The recording external sweep will be started through a steady 315Hz or 1kHz tone, being present for at least 3 second, and followed by a decrease of the frequency. This start condition complies with the international standards for test tapes.

Preparing an External Sweep

1. Set the A2/A2-D in the GRAPH display mode and select the measurement function you want to record.
2. Open the *Sweepmode* menu behind the <SWEEP MODE> key and select *Frequency*.
3. Set the synchronization to EXT by pressing the <SWEEP MODE> key.
4. Choose the start- and stop-frequency of your sweep as described chapter ***Setting the Sweep Limits***.
5. Open the *Resolution* menu behind the <RESOLUTION> key and enter the expected number of sweep samples. This value is used by the A2/A2-D to calculate the frequency increments. This logarithmic frequency increment is calculated as follows

$$\log(\Delta f) = \frac{\log(fStart) - \log(fStop)}{n+1}$$

NOTE ***In the external sweep mode, the A2/A2-D will record exactly the number of points defined through the* Resolution *menu. Even in case that the external source provides a higher resolution (i.e. a higher number of frequency steps), the instrument will perform a measurement only, if an incoming frequency equals the expected one or is higher than it.***

6. Connect the external source to the input of the A2/A2-D through the Device Under Test.
7. Check for the right settings of the external generator and let it start the sweep.
8. If the external sweep starts with a 315 or 1kHz header, the A2/A2-D will display *Freq. STARTING*, to indicate that it is waiting for the sweep to start. The starting condition itself is an abrupt change from the 315 Hz or 1kHz header tone to alower frequency.
9. In case of a missing header, the sweep can be started manually by pressing the <DO SWEEP> button.
10. Every abrupt decrease of the frequency during the sweep recording is interpreted as STOP command (see ***Fig. 24***).

NOTE ***Every analog audio analyzer requires a certain time to settle on the incoming frequency. For this reason, only stepped frequency sweeps may be processed. Preferably, use the* Tape Sweep *of the A2/A2-D to get best results.***

Nevertheless, if the increase of frequency is not too fast, even continuos sweeps may be handled correctly.

List of Reference CD Tracks

Stepped Sweeps

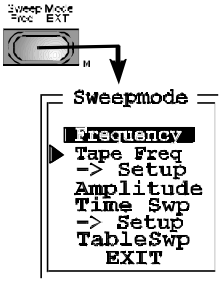
- Test CD Hessischer Rundfunk, Track 18-35, 8s/step, LEVEL, THD+N
- PHILIPS Audio Signals disc 1, Track 8-23, 8Hz-20kHz 60s/step (w/o. 1kHz header)

Gliding Sweeps

- DENON Audio Technical CD Track 36, 20Hz-20kHz in 50s, LEVEL
- Test CD Hessischer Rundfunk, Track 36, 20Hz-20kHz in 50s, LEVEL
- PHILIPS Audio Signals disc 1, Track 5, 20Hz-20kHz in 50s (w/o. 1kHz header)
- PHILIPS Audio Signals disc 1, Track 6, 20Hz-20kHz in 120s (w/o. 1kHz header)

Amplitude Sweep

The A2/A2-D is capable of performing amplitude sweeps in all measurement functions. Again in some measurement functions the variation of the level does not have a big influence on the result which simply is not of interest, e.g. a W&F sweep over the amplitude does not expect any variation.



Activate the *Sweepmode* menu by double clicking the <SWEEP MODE> button. The menu will appear. Move the arrow with the SCALE wheel to the entry *Amplitude* and push the <SCALE> wheel. The menu closes automatically after the selection. *EXIT* or any other keypress leaves the menu without changes.

As soon as you enter the GRAPH display mode, you will find the X-scale as an amplitude range now. The settings for the sweep range is done exactly the same way, except that the generator <LEVEL> wheel is now used for the selection.

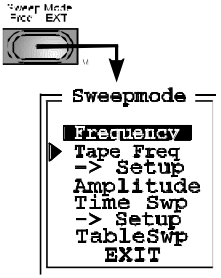
Units of X- / Y-axis

The unit of the X-axis may be either linear [V] or logarithmic [dBV], [dBu] or [dBm], while the unit of the Y-axis must be set in the respective measurement function.

1. Select the amplitude sweep mode as described above.
2. Activate the measurement function Level or 2-CH and choose the unit for the X-axis (V, dBV, dBu/dBm) by pressing the <UNIT> key.
3. Select the measurement function to be recorded (e.g. THD+N), and set the unit for the Y-axis by pressing the <UNIT> key.
4. Choose the start- and stop-values of the amplitude sweep by setting the generator level to the respective values and pressing the <START VALUE> and <STOP VALUE> keys.
5. Set the generator to the required frequency (the output frequency will not vary during the sweep).
6. Start the sweep by pressing <DO SWEEP>.

Time Sweep

The A2/A2-D offers the possibility to record any measurement function vs. time, e.g. to monitor the long-term stability of a signal. In this mode, neither the output frequency, level nor any other generator parameter is altered during the sweep.



To run a time sweep, double-click the <SWEEP MODE> button to open the *Sweepmode* menu.

Below *Time Swp*, select the *->Setup* entry and push the <SCALE> wheel to open the corresponding submenu. Therein, you may specify the overall duration of the time sweep, expressed by a number between 3-180 and the dimensions *Seconds*, *Minutes* or *Hours*.
Make your selection and confirm it by using the <SCALE> wheel or leave the submenu without a change through the EXIT entry.

By this way, you can specify a time sweep lasting a from 3 seconds only up to one that takes almost a week to complete.

The scale of the X-axis always starts at time zero. The resolution of the sweep, i.e. the number of samples to be recorded within the selected sweep duration ***T*** [sec], may be set through the *Resolution* menu, that is hidden behind the <RESOLUTION> key. Keep in mind, that the time interval Δt [sec] equals

$$\Delta t\ [\text{sec}] = \frac{T\ [\text{sec}]}{NoOfSamples}$$

Equation 3 Time Sweep Interval Calculation

and must not be shorter than the settling time, that the A2/A2-D requires for a single measurement (~300msec).

The sweep is started by pressing the <DO SWEEP> button.

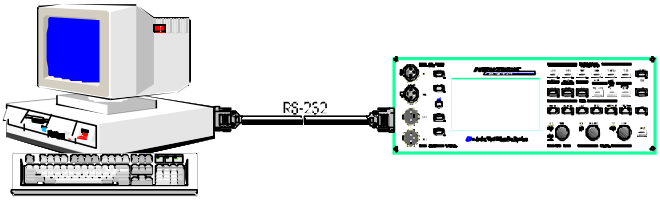
> ***NOTE The Time Sweep mode is the only one, that allows to enter the GRAPH display mode in measurement function W&F. In all other sweep modes, W&F cannot be recorded.***

Table Sweep

As an alternative to frequency sweeps, defined by a start & stop frequency, a fixed output level and number of points, the A2/A2-D also offers the possibility to execute *Table Sweeps*. They are driven by a discrete number of freely defined generator frequencies & levels, at which the measurement function is recorded. Such a set of frequency / Level pairs is called *sweeptable*. Obviously, the output level of a table sweep may be constant, while the set of frequencies must change.

The table sweep mode allows the user to tailor the sweep characteristics to the specific demands of the DUT, or even to define a de-emphasis curve as output signal for a sweep.

The definition of a sweeptable has to be done externally of the A2/A2-D on a PC. It may be downloaded to the instrument either through the serial RS232 or parallel IEEE interface. For this purpose, both the DOS-based AS03 and the Windows-based AS04 software package provide the possibility to define and send sweep tables to the A2/A2-D.



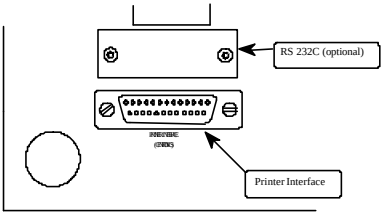
In this way, sweeptables can be defined in a te xtfile format (extension: *.SWT) and stored in the non-volatile memory of the A2/A2-D. Each sweep table may comprise an eight character string for identification. This string is shown on the LCD of the A2/A2-D as soon as the table sweep mode is activated. The time & date of the last downloaded sweeptable is displayed in the bottom line of the GRAPH display when the arrow in the *Sweep Mode* menu is positioned besides the entry *F-Tab Swp*.

Sweep Data Upload to a PC

With the aid of the software packages AS03/AS04, it is also possible to upload all stored graphs from the A2/A2-D to a PC. The data are available both as tables and as graphics and may be exported to other PC programs. For further details please refer to the AS03/AS04 User Manuals.

7. PRINTOUTS

Implemented as a standard feature, the A2/A2-D allows to print out the screen contents in every display mode through the CENTRONICS interface by pushing the <PRINT> button. Various printer drivers as e.g. Epson FX-80, LQ-1000, HP Thinkjet, HP Deskjet/Laserjet and IBM Proprinter are available.



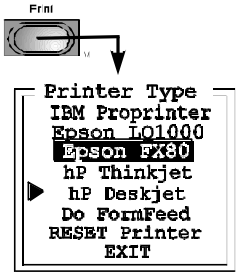
The CENTRONICS printer interface is located on the rear panel of the A2/A2-D. It is a 25-pin D-type connector, of the same type as in PC-compatible computers.

Printer Driver Selection

The A2/A2-D is very flexible and capable to drive a wide variety of different printers. Actually, following printer types are supported.

- IBM Proprinters and its compatibles
- EPSON FX-80 and its compatibles
- EPSON LQ-1000 and its compatibles
- HP Thinkjet
- HP Deskjets / HP Laserjet (PCL3 and PCL5 language)

In case that your actual printer is not listed in this survey, refer to the user manual of your printer for possible emulation modes. Almost all printers may emulate at least one of the types as listed above. If in doubt, please contact your local printer supplier.



To select the printer driver of your choice, open the *Printer Type* menu by double-clicking the <PRINT> button.

The menu offers the list of available printers. Move the arrow on the left hand side by turning the <SCALE> softwheel and place it besides the required printer driver. Confirm the selection by pushing the <SCALE> wheel once.
The two last menu entries, *Do FormFeed* and *RESET Printer* allow to send the respective commands to the printer.

Activation of the *EXIT* entry or any keypress will close the menu without changes.

NOTE The RESET command meets the specific demands of the active printer driver, i.e. will not be understood by the other (inactive) printer types.

Printer Settings

Since there are a lot of possible settings for the different printers, the following list shall give a quick guide for the DIP switch settings of those printers who have been tested to operate properly with the A2/A2-D.

EPSON FX-80, IBM Proprinter

Parameter	***Settings***
Page length	8"
Automatic form feed	OFF (inactive)
Automatic line feed	OFF (inactive)
Automatic CR	OFF (inactive)
Print Quality	Selectable by user
Graphics density	120dpi
Text density	12cpi

EPSON LQ-550 / LQ-1050

	LQ - 550		***LQ - 1050***	
Switch	***Set***	***Function***	***Set***	***Function***
SW1 1	ON	Character set USA	ON	Character set GER
SW1 2	ON	Character set USA	OFF	Character set GER
SW1 3	ON	Character set USA	ON	Character set GER
SW1 4	ON	Draft quality	OFF	Cursive
SW1 5	ON	Draft quality	OFF	Bi-directional print
SW1 6	OFF	Condensed printing	OFF	not used
SW1 7	ON	Graphics	ON	Single sheet
SW1 8	OFF	Single sheet	ON	6k Buffer
SW2 1	ON	12" Page length	ON	12" Page length
SW2 2	ON	Skip over perforation	OFF	Skip over perforation
SW2 3	OFF	Switched off	OFF	Parallel interface
SW2 4	OFF	Auto LF	OFF	Parallel interface
SW2 5	ON	8k Buffer	OFF	Baudrate (not used)
SW2 6	ON	Print bi-directional	OFF	Baudrate (not used)
SW2 7	OFF	10cpi	OFF	Hyphenate
SW2 8	OFF	10cpi	OFF	Auto LF

hp Laserjet, Deskjet

No settings required. All printers with PCL3 or PCL5 language may be controlled in this mode. This covers almost all HP printers, including the color printer types that support black&white printouts.

Printer Error

In case that it is not possible to properly communicate with the printer, an error message will appear on the LC display of the A2/A2-D.

```
     Printer ERROR
or no printer connected
```

The reason for this message may be one of the following.

- Printer not connected to the CENTRONICS parallel interface of the A2/A2-D
- Printer is switched OFF
- Printer is Offline
- No paper in the printer

Any keypress to the A2/A2-D2 lets the error message disappear and return to normal operation.

8. INSTRUMENT SETUP

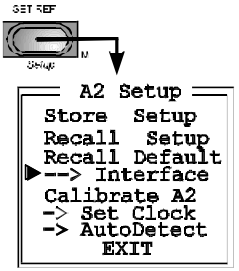
Store & Recall Setups

The A2/A2-D stores its actual setup when it is switched off. This means, that after the next power-up, the instrument automatically resumes with the same settings.

Furthermore, the A2/A2-D offers the possibility to store another setup in an internal non-volatile memory location.

The stored parameters are the actual

- display mode
- measurement function
- filter(s)
- generator settings
- sweep setup



To memorize a special setup as well as to recall this stored or to recall the factory settings, open the *A2 Setup* menu by double-clicking the <SET REF> key.

Move the arrow to the selection *Store Setup* and confirm by turning and pushing the <SCALE> wheel. There is only one location available for a user-defined setup.

Leave the menu without a change through the entry *EXIT* or by any other keypress.

NOTE ***Keep in mind, that if the default setup is recalled, the current settings are lost, unless they have been saved before.***

Calibration

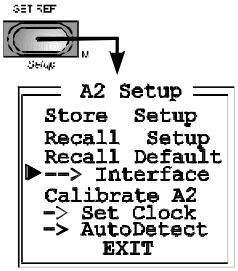
The A2/A2-D has been designed to require almost no maintenance. Actually, the A2/A2-D is able to re-calibrate itself automatically, by measuring the parameters of each internal amplifier, filter and rectifier. These parameters are stored in a table and used for calculation of the measurement results.

This re-calibration procedure may be processed if the A2/A2-D is used in extreme environments, as e.g. with very high / low temperatures or humidity.

Re-calibration of the A2/A2-D should be carried out by qualified personnel only. Contact your NTI agent if in doubt.

To start the re-calibration procedure, proceed as follows.

1. **Warm up the instrument for at least 15 minutes!**
2. Disconnect all cables from the input and output connectors.
3. Activate the *A2 Setup* menu behind the <SET REF> button by double-clicking it.



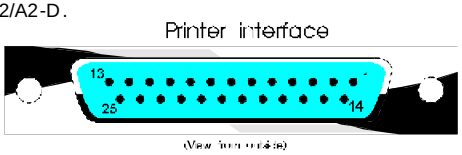
4. Move the arrow to the entry *Calibrate A2* with the <SCALE> softwheel.
5. Confirm the selection by pushing the <SCALE> wheel. The calibration sequence starts, indicating the actual step with a message on the display. For interpretation of the messages, please refer to the A2/A2-D service manual. The whole procedure takes about two minutes to measure all the stages.

If the calibration is aborted with an ERROR message in the display, make sure that the unit has been properly warmed up before and re-try the calibration. Contact your local NTI distributor in case of several failures in a calibration.

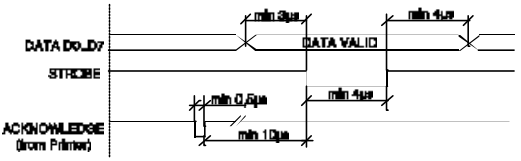
Connector Pin Assignment

Centronics Connector

The CENTRONICS 8bit parallel interface is equipped with a female 25-pin D-Sub connector that is fully compatible to PC computers. Use a shielded standard Printer cable to connect your printer to the A2/A2-D.



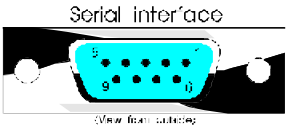
Timing Diagram



RS232 Connector

The RS232 interface is a fully PC compatible serial interface using the female 9 way Sub D connector. The A2 acts as the DCE unit and has therefore the lines already twisted, so that the cable to connect to the PC is a straight connected through cable.

The baudrate is selectable in the setup menu. Please refer to ***Baudrate Selection***, on page ***90*** for their settings.



Pin No	*Name*	*Type*	*Description*
1	+5V	Output	+5V from A2
2	TXD	Output	Send DATA
3	RXD	Input	Receive DATA
4	DTR	Input	Data terminal ready?
5	RSGND	I/O	DATA GND
6	DSR	Output	Data set ready! (+5V)
7	CTS	Input	Clear To Send
8	RTS	Output	Request To Send
9	--	--	NC

Cable

To connect the A2/A2-D serial interface with the PC, a standard 1:1 cable is required, which can be purchased easily. When assembling the cable yourself, please follow the wiring shown below.

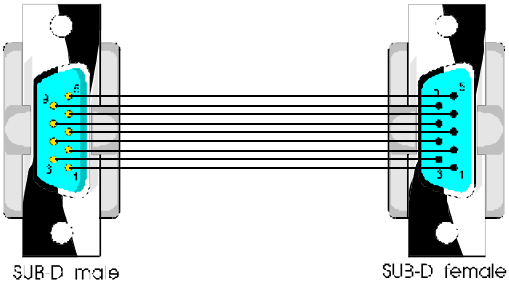


Fig. 25 MD9 Male to MD9 Female

9. OPTIONS & ACCESSORIES

The following tables list all available options and accessories of the A2/A2D with a brief description of their characteristics and performance. Please notice, that all options must be installed by NTI or an authorized representative to maintain the warranty.

Options Overview

Code	*Article*
AO1	**RS232 interface** with MS-DOS based software package **AS03** for remote control of the analog functions of the A2. The included easy-to-learn Audio Measurement Programming Language (AMSL) allows to build up sequences and PASS/FAIL tests for automated applications. Demo disk available.
AO4	**A-weighting filter** according to IEC 651. The filter may be activated with the <WTD UWTD> key. For 2-chn. measurements, two filters are required.
AO5	**User definable filter**. A pre-wired board containing four operational amplifiers and the switching electronics, but without passive components. The user can build up a four-pole active filter with freely setable frequency response. For 2-chn. measurements, two filters are required.
AO7	**Transformer output** option. Adds a transformer behind the electronically balanced output stage.
AO8	**Phantom power** option. Installs either +15V or +48V phantom power to both input channels. Replaces the low input impedance (200Ω / 150Ω).
AO10	**Digital option** PCB to upgrade an A2 instrument to an A2-D. The option allows the generation and analysis of digital Audio signals according to AES and IEC958 standards. Provides digital peak level, RMS level, THD+N, sampling frequency, jitter, status and bit statistics analysis. Supports mixed signal applications.
AO11	**IEEE-488 interface** for A2/A2-D. Allows remote control all functions of the instrument through a GPIB interface. Cannot be installed together with RS232.
AO12	**FFT** option for A2-D. Performs spectral analysis of the main input channel. Provides Windowing functions, Zoom & Scroll of axis as well as direct printouts.
AO13	**C-Message filter**. The filter may be activated with the <WTD UWTD> key. For 2-chn. measurements, two filters are required.
AO14	**80kHz lowpass filter**. The filter may be activated with the <WTD UWTD> key. For 2-chn. measurements, two filters are required.
AO15	**Update software** package from AS03 to AS04. Utilizes the AS03 interface.
AO16	**High speed RS232** interface with Windows-based software package **AS04**. Allows the remote control of all analog and digital functions of the A2 or A2-D. Provides additional features, thus enhancing the performance of the instrument. The included, easy-to-learn Audio Measurement Programming Language (AMSL) allows to write sequences and PASS/FAIL tests for automated applications. Supports conversion of AS03 AMSL programs. Demo disks available.

RS232 Serial Interface (AO1 / AO16)

Both options comprise the hardware board to allow the physical communication according to RS-232 and either the software package AS03 or AS04. Both packages come on 3½" HD diskettes with separate User Manual.

- The AS03 allows to comfortably control all analog functions of the A2. Requires a MS-DOS PC with 286 processor or higher.
- The Windows™ based AS04 software package is able to control all analog and digital features of the A2 or the A2-D, under a minimum configuration of a 486 CPU with co-processor, Windows™ 3.1 or higher and 8MB RAM.

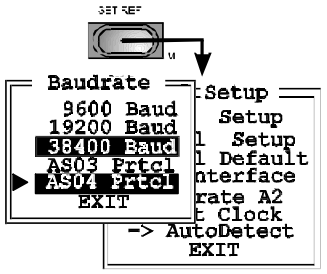
The serial interfaces have the following communications parameters.

	AO1	**AO16**
Protocol	AS03	AS03 / AS04
Selectable baud rate	2400 / 4800 / 9600	9600 / 19200 / 38400
Data bits	8	8
Stop bits	1	1
Parity	even	even

An upgrade package from AS03 to AS04 (comprising the software upgrade only) is also available.

Baudrate Selection

To select the communication protocol and the baudrate (communication speed) of the serial interface, open the *Baudrate* menu behind the <SET REF> key and select the entry -> *Interface*.



Depending on the installed interface (AO1 or AO16), the submenu menu offers the available baudrates and protocols. The example is shown for the interface AO16, providing the three baudrates 9600, 19200 and 38400 baud, as well as both the AS03 and AS04, protocol.

To alter the selection, move the arrow with the <SCALE> wheel to your new choice and push the wheel to make the selection active.

Leave the menu without a change through the *EXIT* entry or any keypress.

The connection to the PC is performed through a female 9-pin D-Sub connector. For pin layout and description, see chapter ***RS232 Connector***.

Filter Options

The A2/A2-D allows to install weighting filter(s) on the main or both input channels. The available filter characteristics are

- the standard A-weighting filter (AO4)
- a customer specific filter (AO5).
- the C-Message weighting filter (AO13) or
- the 80kHz lowpass filter (AO14).

A-Weighting Filter (AO4)

Frequency [Hz]	*Gain [dB]*	*Frequency [Hz]*	*Gain [dB]*	*Frequency [Hz]*	*Gain [dB]*
20	-50.5	*200*	-10.9	*2000*	+1.2
25	-44.7	*250*	-8.6	*2500*	+1.3
31.5	-39.4	*315*	-6.6	*3150*	+1.2
40	-34.6	*400*	-4.8	*4000*	+1.0
50	-30.2	*500*	-3.2	*5000*	+0.5
63	-26.2	*630*	-1.9	*6300*	-0.1
80	-22.5	*800*	-0.8	*8000*	-1.1
100	-19.1	*1000*	0	*10000*	-2.5
125	-16.1	*1250*	+0.6	*12500*	-4.3
160	-13.4	*1600*	+1.0	*16000*	-6.6
				20000	-9.3

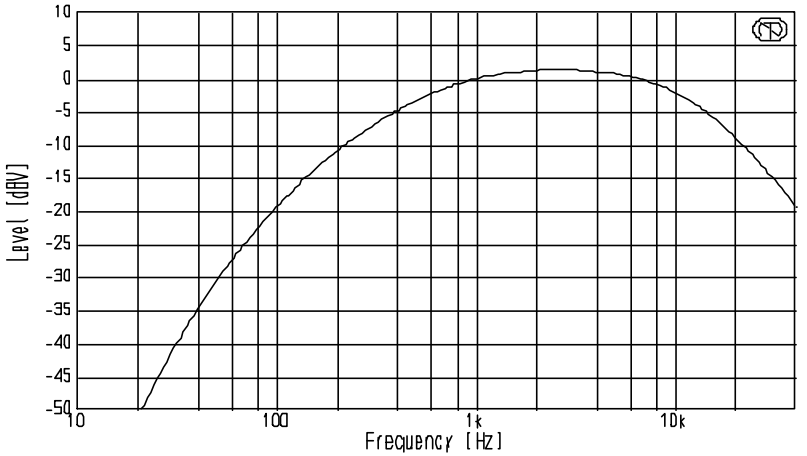


Fig. 26 A-Weighting Filter Characteristics

User Filter (AO5)

The user filter comprises a PCB with four operational amplifiers and the switching electronic to enable and disable the filter(s). The space around these devices is reserved to add passive components like resistors and capacitors , thus allowing to deaign a custom -specific filter characteristic.

Possible applications of the User-filter are

- Fixed lowpass filter with 80dB / decade (24dB / octave) at any frequency
- Fixed highpass filter with 80dB / decade (24 dB/octave) at any frequency
- Fixed bandpass filter with 40dB / decade steepness at any frequency
- Any characteristics consisting of up to four kink points

In case of questions about the filter design or realization, contact your local NTI agency.

User Filter board AO5

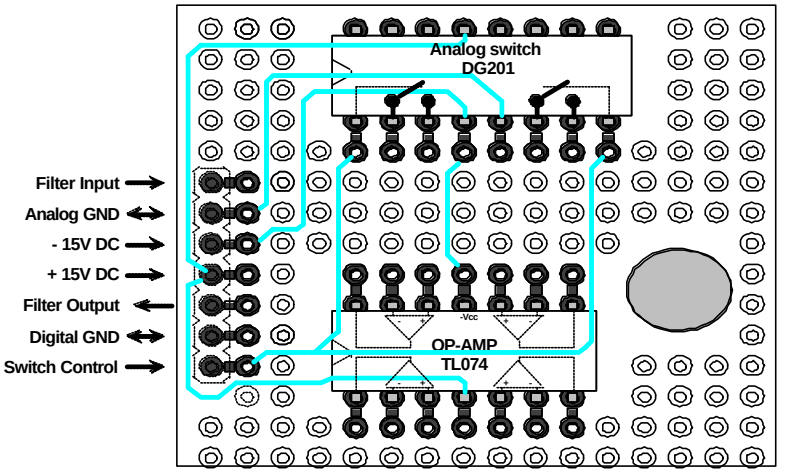


Fig. 27 User Filter Layout

C-Message Filter (AO13)

Frequency [Hz]	Gain [dBV]	Limits [±dBV]	Frequency [Hz]	Gain [dBV]	Limits [±dBV]
60	-55.7	2	1300	-0.7	1
100	-42.5	2	1500	-1.2	1
200	-25.1	2	1800	-1.3	1
300	-16.3	2	2000	-1.1	1
400	-11.2	1	2500	-1.1	1
500	-7.7	1	2800	-2.0	1
600	-5.0	1	3000	-3.0	1
700	-2.8	1	3300	-5.1	2
800	-1.3	1	3500	-7.1	2
900	-0.3	1	4000	-14.6	3
1000	0.0	reference	4500	-22.3	3
1200	-0.4	1	5000	-28.7	3

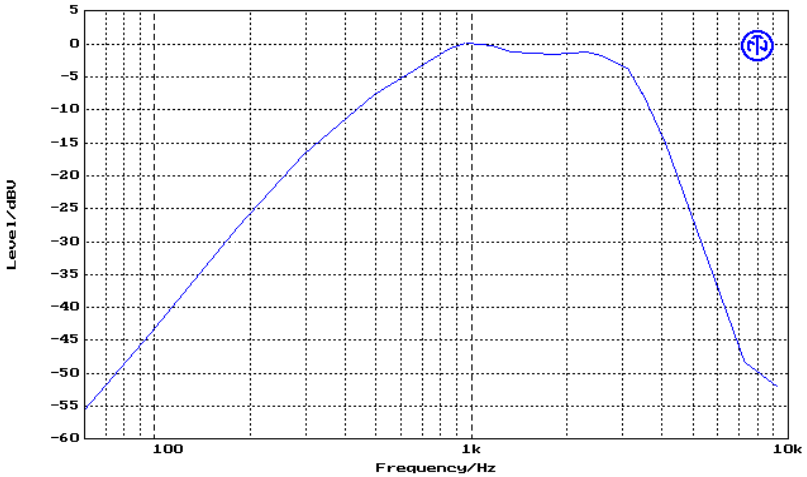


Fig. 28 C-Message Filter Characteristics

80kHz Lowpass Filter (AO14)

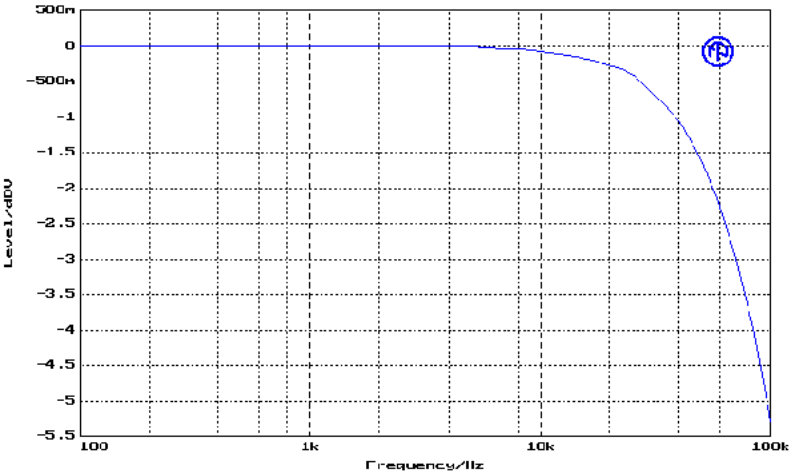
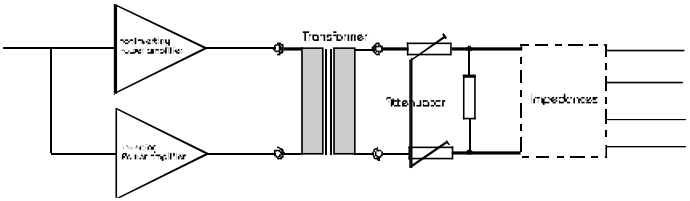


Fig. 29 80kHz Lowpass Filter Characteristics

Transformer Option (AO7)

The transformer option adds a high-quality Audio transformer behind the power amplifier of the A2/A2-D. This features mainly allows an additional galvanic separation of the generator output and a perfect balancing of the outputs.



The generator specifications remain the same with and without the transformer and also the impedance circuitry remains active.

Phantom Power (AO8)

The A2/A2-D can be equipped with Phantom power on both inputs. Installing phantom power replaces the lowest input impedance of 200Ω (150Ω).

The Phantom power option allows to select either +15V or +48V as supply voltage level in the installation process. It is fixed and can be changed by soldering only.

> ***NOTE*** ***As soon as the Phantom power option is installed, the lowest input impedance is no more available.***

Accessories Overview

Code	***Article***
AA10	**Soft carrying bag** for A1, A2 or A2-D. Perfectly protects the instrument on all sides. Allows the instrument to be operated in the bag even in vertical position. Comes complete with shoulder strap.
AA12	**Additional User Manual** (this document).
AA21	**A2/A2-D Service Manual**. Contains all schematic diagram, assembly drawings and the complete calibration procedure.
AA22	**Modem Cable**. Allows the remote control of an A2/A2-D instrument from a PC through a modem link under AS04 software. Requires installation of the RS232 interface.
3382	¼" Measuring **Microphone**.
3384	½" Measuring **Microphone**.

10. TECHNICAL SPECIFICATIONS

Analog Generator

Signals	Pure & Warbled Sine, Symmetric & Asymmetric Squarewave, Triangular Wave, Pink & White Noise, IMD-Testsignals (see IMD)	
Frequency range	10Hz-100kHz	for Sine signal
	10Hz-20kHz	for Squarewave and Noise
	20Hz-40kHz	for Warbled Sine
	4kHz-40kHz	for IMD Signal
Frequency Resolution	< 0.05%	
Frequency Accuracy	± 0.01% of defined value	
Output Level	10µV - 24.5Vrms (-100dBV to 27.7dBV)	
Level Resolution	< 0.05 dB	
Level Accuracy (o.c.)	0.5% of defined value	
Flatness	± 0.05 dB, 20Hz-20kHz, Ref = 1kHz, 0.05% typ.	
Output Impedance	< 15Ω, 150Ω (200Ω), 600Ω	
Residual THD+N	typ. -94dB (0.002%), < -90dB max. or 10µV, 20Hz-20kHz, unloaded, DIN audio BP	
Square wave	rise & fall time < 5µs (unloaded)	
IMD-Signal	f1: 60Hz or 250Hz, f2: 4kHz-40kHz, ratio 1:1, 4:1, 10:1, sweeptable	

Digital Generator

Output Format	Professional according AES-3 and Consumer according IEC958, optical TOS link
Impedance	110Ω, 75Ω
Sampling Frequency	32kHz, 44.1kHz, 48kHz or input clock or analyzer clock
Frequency Accuracy	± 10ppm (± 2ppm on request)
Detune	± 1500ppm
Resolution	4-24bits
Dithering	TPDF switchable
Jitter Generation	2-40ns with selectable modulation signal
Output Level	0.15-5Vpp
Trigger Output	X-, Y-, Z-Preamble, Bitclock

Sweep Function

Modes	Frequency-, Amplitude-, Time- & Tablesweeps over entire generator range
Sweep Resolution	3-200 points
External Sweeps	automatically synchronized

Analog Analyzer

Number of Channels	2 simultaneously operating inputs, balanced, fully differential

Impedance	100kΩ / 50pF, 600Ω, 200Ω (150Ω) selectable
Input voltage	max. 300V peak / 200Vrms
Phantom Power	optional +15V or +48V replaces 200Ω (150Ω) impedance
CMRR	> 80dB (20Hz - 20kHz)

Digital Analyzer

Input Format	Professional according AES-3 and Consumer according IEC 958, optical TOS link
Impedance	110Ω, 75Ω
Sampling Frequency	32kHz, 44.1kHz, 48kHz, house clock or input clock
Locking Range	25-52kHz
Measuring Accuracy	2ppm
Jitter Function	0.1-40ns continuously measured
Input Level	0.1-10Vpp

Level Function

Range	1µV-200V (-120dBV to +46dBV)
Residual Noise	< 1.5µV (short circuit, 22Hz-22kHz)
Flatness	± 0.05dB (20Hz-40kHz), ± 0.1dB (full band)
Rectifier Type	true RMS
3dB Bandwidth	> 250kHz

Total Harmonic Distortion (THD + N)

Fundamental Range	10Hz-50kHz
Display Range	0.001-100% (-100dB to 0dB)
Input Voltage	5mV-200V
Residual THD+N	< -95dB typ. (DIN audio BP)
Input > 0dBV	< -92dB (0.0025%) or 10µV (DIN audio bandpass)
3dB Bandwidth	2Hz-250kHz
Rectifier Type	true RMS

Phase

Frequency	10Hz-100kHz
Level Range	10mV-200V
Level Difference	< 18dB
Accuracy	± 1° (20Hz-40kHz)

IMD

Standards	DIN 45403, SMPTE and TH 22.51
Frequency Ratio	1:1, 4:1, 10:1
Low Frequency	60Hz, 250Hz
High Frequency	4kHz-40kHz sweepable

Residual IMD	< -90dB (U > 0dBV, 1:1 @ 4kHz)

Crosstalk / Level Selective

Range	10Hz-50kHz
Accuracy	± 0.3 dB
Filter	tracking 2-pole BP, Q=5
Rectifier	true RMS
Residual Noise	< 0.7 µV (< 123dBV), Ref. = 1kHz, DIN audio BP

Noise

Filter Weighted	CCIR 468-3
Filter Unweighted	DIN audio bandpass, 22.4Hz-22.4kHz
Rectifier	quasi-peak according CCIR 468-3
Residual Noise	< -104dB weighted (quasi-peak) < -108dB unweighted (quasi-peak) < -116dB weighted (RMS)

Wow & Flutter Function

Standards	IEC 386, DIN 45507, CCIR 409, BS 4047:1972 (quasi peak), NAB, JIB C 5551 (RMS)
Range	0.1-10% full scale
Accuracy	± 3% of reading
Frequency	3kHz or 3.15 kHz
Input Voltage	100mV-100V

Drift

Range	± 15 %
Accuracy	± 20ppm (± 0.002%)

Frequency Function

Display Mode	Continuous
Frequency Range	10Hz-200kHz
Resolution	min. 0.1%
Accuracy	± 0.05 %

Scope Function

Trigger Mode	Auto
Scaling	Auto, 100µV-20V / Div.
Time Base	Auto, 10 µs-20ms / Div.
Sampling Rate	max. 2MS/s

Filters

400Hz Highpass	± 10%, 3-pole
Bandpass	22.4Hz-22.4kHz (DIN), ± 10%, 3-pole
Noise Filter	CCIR 468/4
Selective Filter	2-pole tracking bandpass, Q=5
Psophometric Filter	A-weighted according IEC 651 (optional)

Display (of A2/A2-D)

256 x 128 dot backlit graphics LCD module. Measurement display with large 15mm numeric values and two 100mm Bargraphs.

Interfaces

Centronics compatible, parallel printer port (25pin Sub-D) for graphics and text printouts. Supports Epson FX and LWQ, IBM Proprinter, HP Deskjet, Thinkjet and Laserjet printers.

RS232 serial port (optional) for remote control and data transfer between A2 and IBM PC compatible computer.

IEEE-488 parallel remote control interface (optional) for remote control and data transfer between A2 and PC..

BNC monitor outputs offering both input channels and reading signal; level typical 3Vpp, Rout = 600Ω.

General Data

Dimensions	274 x 396 x 132mm (11" x 15" x 5")
Weight Approx.	9kg (20lbs)
Fab. Requirements	100 / 120 / 230 / 240VAC, 50 / 60Hz, 85VA
Temperature Range	0-45°C (32-113°F)
Humidity	10-90% R.H. non condensing

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